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NATIONAL DAM SAFETY PROGRAM. TEAL LAKE DAM (MO-10082), MISSOURI--ETC(U)

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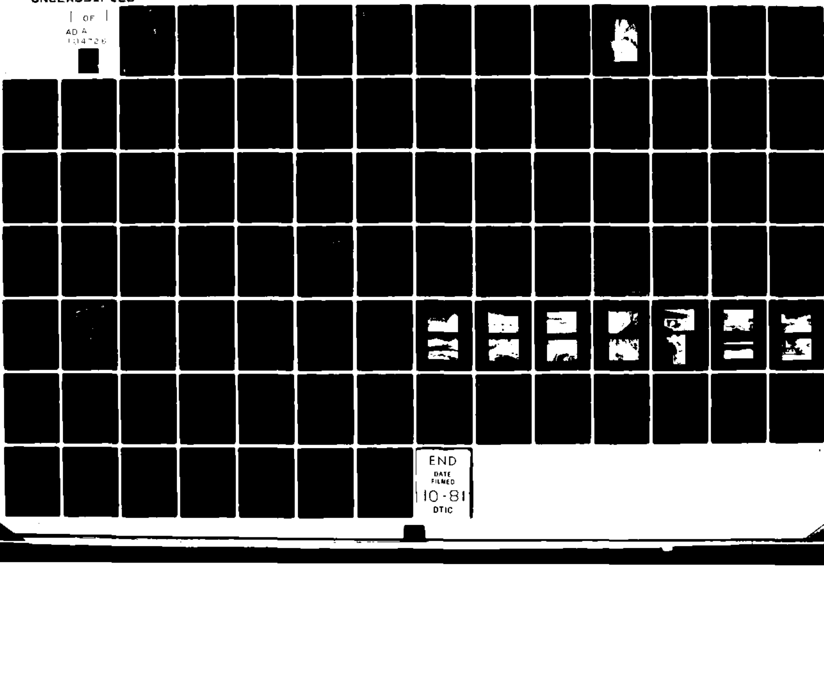

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MISSOURI · KANSAS CITY RIVER BASIN

TEAL LAKE DAM
AUDRAIN COUNTY, MISSOURI
MO. 10082

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

(6) Teal Lake Dam (MO- 10082) Missouri - Kansas City River Basin. Audrain County, Missouri Phase I Inspection Report.

(15) DACW43-80-C-0094 (9) Final rept.

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St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

NOVEMBER, 1980

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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

LMSED-P

SUBJECT: Teal Lake Dam (MO 10082) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Teal Lake Dam (MO 10082).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, emergency by the St. Louis District as a result of the application of the following criteria:

a. Spillway will not pass a 10-year frequency flood without overtopping of the dam. The spillway is, therefore, considered to be unusually small and seriously inadequate.

b. Overtopping could result in dam failure.

c. Dam failure significantly increases the hazard to life and property downstream.

SUBMITTED BY: SIGNED — 18 DEC 1980
Chief, Engineering Division — Date

APPROVED BY: SIGNED — 22 DEC 1980
Colonel, CE, District Engineer — Date

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TEAL LAKE DAM
AUDRAIN COUNTY, MISSOURI

MISSOURI INVENTORY NO. 10082

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

NOVEMBER 1980

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Teal Lake Dam, Missouri Inv. No. 10082
State Located:	Missouri
County Located:	Audrain
Stream:	An unnamed tributary of the South Fork Salt River
Date of Inspection:	July 10, 1980

Assessment of General Condition

Teal Lake Dam was inspected by the engineering firms of Consoer, Townsend and Associates, Ltd., of St. Louis, Missouri, and PRC Engineering Consultants, Inc., of Englewood, Colorado, (a joint venture) according to the U.S. Army Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Within the estimated damage zone of two miles downstream of the dam are two dwellings, three buildings, one railroad bridge, and a school which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Teal Lake Dam is in the small size classification since it is 20 feet high, and impounds more than 50 acre-feet but less than 1,000 acre-feet of water.

The inspection and evaluation by the consultant's inspection team indicates that the spillway of Teal Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Teal Lake Dam being a small size dam with a high

hazard potential is required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping. Considering the number of inhabited dwellings and a school being located within one mile downstream of the dam, the PMF is considered the appropriate spillway design flood for Teal Lake Dam. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. It was determined that the reservoir/spillway system can accommodate approximately 12 percent of the Probable Maximum Flood without overtopping the dam. The evaluation also indicates that the reservoir/spillway system cannot accommodate the ten-percent chance flood (10-year flood) without overtopping.

Other deficiencies noted by the inspection team were: the erosion on the downstream slope and the left abutment due to steep slopes and lack of protective grass cover, lack of adequate protection against erosion on the upstream slope, the small trees observed on the downstream slope, the bulges observed in the two spillway pipes, the two sections of the pipe on the far left side of the spillway which were cut out of the bottom of the conduit and the rusting of the bottom of this pipe, the erosion near the right wingwall of the headwall of the spillway, a need for periodic inspection by a qualified engineer and a lack of maintenance schedule. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

Walter G. Shifrin, P.E.

STATE OF MISSOURI
WALTER
G SHIFRIN
NUMBER
E-8834
REGISTERED PROFESSIONAL ENGINEER

Overview of Teal Lake Dam

NATIONAL DAM SAFETY PROGRAM

TEAL LAKE DAM, I.D. No. 10082

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

TEAL LAKE DAM, Missouri Inv. No. 10082

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Teal Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of Consoer, Townsend & Associates, Ltd., and PRC Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Teal Lake Dam was made on July 10, 1980. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site, and the structural adequacy of the various project features and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the northwest abutment or side, and right to the southeast abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase 1 Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based exclusively upon observations and measurements made during the visual inspection and from conversations with Messers. Jim Dalton, Jim Maunder, and Dennis Hammen, representatives of A.P. Green Refractories Co. Design

drawings were available for this dam and are included as a part of this report (see Plates 3 through 6). There were no discrepancies between our field notes and the design drawings.

The dam was originally constructed in 1938, as further described in Section 1.2g, and was partially reconstructed in 1966, as described below. The dam is a rolled, earthfill structure with a straight alignment between natural soil abutments. A plan and elevation of the dam are shown on Plate 2 and Photos 2 and 5 show views of the dam. The top of dam varies in width from 60 feet at the location where the spillway passes through the embankment to 35 feet for the rest of the embankment. The length of the dam was measured to be approximately 200 feet. The top of dam was measured to be level from the left abutment to a point 60 feet to the left of the right abutment. From this point, the top of dam slopes upward with a rise in elevation of 3 feet before meeting the right abutment area. The top of dam elevation was found to be at 760.33 feet above mean sea level (M.S.L.) at the location of the spillway assuming the crest of the spillway is at 753 feet above M.S.L. The portion of the upstream face at the spillway is a vertical headwall while the remainder of the upstream face was measured to have an average slope of 1 vertical to 2.25 horizontal (1V to 2.25H) above the water surface. The downstream slope was measured to be on the average 1V to 1.5H.

Only one spillway was provided for this dam which consists of five, 65-inch by 40-inch corrugated metal pipe-arches, spaced approximately 8.0 feet apart. The pipe-arches pass through the embankment at about the mid-third of the dam on a grade of about 13 percent and are 80 feet in length. At the upstream end of the spillway, an 1-foot thick headwall was provided that has 20-foot long wingwalls at each end that extend downstream at a 45-degree angle (see Photo 1). A 5-foot wide concrete apron, which extends outward from the headwall at the invert of the pipe-arches, was also provided (see Photo 9). At the downstream end of the pipes, discharges through the spillway drop approximately 1.5 feet into the

discharge pond. A 4-foot high trashrack was provided at the entrance to the spillway that consisted of wire mesh strung between a metal framework.

No low level outlets or outlet works were provided for this dam.

b. Location

Teal Lake Dam is located in Audrain County in the State of Missouri, and crosses an unnamed tributary of South Fork Salt River. The community of Mexico is about 3/4 mile to the north of the dam. The Teal Lake Dam location on the 7.5 minute series of the U.S. Geological Survey maps is found in Section 36 of Township 51 North, Range 9 West, of the Mexico East, Missouri Quadrangle Sheet.

c. Size Classification

The impoundment of Teal Lake Dam is less than 1,000 acre-feet but more than 50 acre-feet, and the height is 20 feet. Therefore, the size is determined to fall in the "small" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. The findings of the consultant's inspection team concur with this classification. There are two dwellings, three buildings, one railroad bridge and a school within the estimate damage zone, extending two miles downstream of the dam.

e. Ownership

Teal Lake Dam is privately owned by A. P. Green Refractories Co. of Mexico, Missouri. All correspondence are directed to Mr. Jim Maunder, Manager of Manufacturing, A. P. Green Refractories Co., Green Blvd., Mexico, Missouri, 65265.

f. Purpose of Dam

According to Mr. Maunder, the dam was constructed to provide a recreational lake and a truck haul road.

g. Design and Construction History

According to the information obtained from Mr. Jim Maunder of A. P. Green Refractories Co., the dam was originally designed in 1938 and it is presumed that the design was performed by A. P. Green personnel. Mr. Maunder also believes that A. P. Green personnel were responsible for the original construction. According to Mr. Maunder, the lake was originally a clay pit that was converted to a recreational lake for the employees of A. P. Green Refractories Co. The original dam consisted of a 12-foot high by 200-foot long earth embankment with upstream and downstream slopes of 1V to 3H and 1V to 2H, respectively. A benched, core trench was also part of the construction that was 12 feet wide at the ground surface and was stepped down 3 times to a width of 4 feet at the bottom of the 17-foot deep excavation. The core trench was constructed to a hard clay foundation. Backfill was indicated to be select clay material placed in approximately 6-inch compacted lifts in the core trench area and 1-foot loose lifts in the embankment. A 200-foot long and 80-foot wide heavy, rubble, stone masonry spillway was provided. A pier was placed in the center of the spillway to accommodate two, 40-foot bridge spans.

The dam was essentially rebuilt in 1966 by replacing most of the 1938 structure with the existing embankment and pipe-arch spillway. Several post construction changes and repairs were made on the dam since the 1966 reconstruction and are described in Section 6.1.d. According to the design drawings, a portion of the original spillway appears to be buried in the embankment (see Plate 3).

No emergency spillway was provided for this dam; however, according to Mr. Jim Dalton of A. P. Green, a 2-foot by 3-foot channel was cut through the embankment just to the left of the spillway during a period of heavy rainstorms in 1977. This was done as a precautionary measure and later, the trench was filled in and compacted.

h. Normal Operational Procedures

There are no specific operational procedures for this dam; however, during periods of heavy rainfall, A. P. Green Co. personnel check the performance of the spillway and observe the reservoir level.

1.3 Pertinent Data

a. Drainage Area (square miles): 6.43

b. Discharge at Damsite

Estimated experienced maximum flood (cfs):	3,600
Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs):	1,327

c. Elevation (Feet above M.S.L.)

Top of dam (minimum):	760.33
Spillway crest:	753
Normal Pool:	753
Maximum Experienced Pool:	761.8
Observed Pool:	753

d. Reservoir

Length of pool with water surface at top of dam elevation (feet):	4,500

e. Storage (Acre-Feet)

Top of dam (minimum):	896
Spillway crest:	179
Normal Pool:	179
Maximum Experienced Pool:	1,100
Observed Pool:	179

f. Reservoir Surfaces (Acres)

Top of dam (minimum):	132
Spillway crest:	67
Normal Pool:	67
Maximum Experienced Pool:	146
Observed Pool:	67

g. Dam

Type: . . . . Earthfill

Length: . . . . 200 feet

Structural Height: . . . . 20 feet

Hydraulic Height*: . . . . 20 feet

Top width: . . . . 60 feet or 35 feet outside of spillway section

Side slopes:

Downstream . . . . 1V to 1.5H

Upstream . . . . Vertical or 1V to 2.25H outside of spillway section (Above the water surface)

Zoning: . . . . Homogeneous

Impervious core: . . . . NA

Cutoff:. . . . . Unknown, (original core trench may have been undisturbed during the 1966 reconstruction)

Grout curtain: . . . . Yes, remedial measure in 1967(see Plate 4).

Freeboard above
Normal reservoir level: . . . . 7.3 feet (minimum)

Volume: . . . . 3,025 cu. yds. (According to design drawings)

h. Diversion and Regulating Tunnel . . . . . None

i. Spillway

Type: . . . . Culvert, five, 65-inch by 40-inch corrugated metal pipe-arches

Length of crest: . . . . NA

Crest Elevation
(feet above M.S.L.). 753

j. Regulating Outlets. . . . . None

* The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of dam or the maximum water surface, if below the top of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

A four sheet set of engineering drawings was obtained from A. P. Green Refractories Co. and are included as part of this report (see Plates 3 through 6). A three page set of "Plant Engineering Job Orders" which illustrates part of the original 1938 construction were also made available. No specific information regarding sub-surface soils or embankment compaction were available.

2.2 Construction

The only construction data available is the three page set of "Plant Engineering Job Orders" illustrating the 1938 construction. No data is available concerning the 1966 construction other than the construction history furnished by Mr. Maunder of A. P. Green, which is outlined in Section 1.2.g.

2.3 Operation

No operational records are available for Teal Lake Dam.

2.4 Evaluation

a. Availability

The availability of engineering data is fair and consists of a four page set of drawings which deal with the present condition of the dam and spillway. A list of post construction changes was furnished by the owner's representatives. Other sources of information included State Geological Map, a general soils map published by the Soil Conservation Service, and U.S.G.S. Quadrangle sheets. No information on design hydrology is available.

b. Adequacy

The conclusions presented in this report are based on field measurements, the available engineering data, past performance and present condition of the dam. The available data including the field measurements taken by the field inspection team are considered adequate to evaluate the hydraulic and hydrologic capabilities of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

A four page set of engineering drawings were available for review. From field measurements and conversations with representatives of the owner, the dam appears to have been constructed according to the available drawings.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Teal Lake Dam was made on July 10, 1980. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Dr. M.A. Samad	PRC Engineering Consultants, Inc.	Project Engineer, Hydraulics and Hydrology
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Civil and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
Zoran Batchko	PRC Engineering Consultants, Inc.	Soils
Kevin J. Blume	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Jim Dalton	A.P. Green Refractories, Co.	
Jim Maunder	A.P. Green Refractories, Co.	
Dennis Hammen	A.P. Green Refractories, Co.	

Specific observations are discussed below.

b. Dam

The top and the downstream slope of the embankment do not have a protective vegetative cover. The surficial soil covering the embankment is known locally as Missouri Flint Clay and apparently has little erosion resistance in its present state without vegetative cover. Deep erosion channels and gullies are evident on the interface between the embankment and abutment contacts, especially on the downstream slope. The downstream slope is fairly steep which would seem to accelerate the erosion on the slope. The right abutment area with vegetative cover is less eroded. The left downstream abutment does not have any vegetative cover and has been eroded severely (see Photos 7 and 8). Several small trees were observed growing on the right side of the downstream slope. These trees appeared to be tipped in the downstream direction. No signs of instabilities, such as cracks, bulges or depressions, were apparent either on the top of dam or downstream slope. However, the erosion of the downstream slope does effect the stability of the slope. According to Mr. Dalton, the dam has been overtopped and this could be the reason for the severe erosion on the downstream slope. No seepage was apparent through the embankment, however, due to the elevation of the tailwater it could not be determined if there was any seepage through the foundation.

The upstream slope does not have any protective vegetative cover against surface runoff and wave action outside of the headwall of the spillway. However, no major erosional problems were observed. The upstream slope appeared to be stable with no apparent signs of instabilities.

The right abutment slopes gently upward from the top of dam while the left abutment is at approximately the same elevation as the top of dam. No signs of instabilities were observed on either abutment, however, the erosion on the left abutment does pose a danger to the abutment.

No evidence of burrowing animals was observed on either of the abutments or the embankment.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of the South Fork of the Salt River in the Dissected Till Plains Section of the central Lowland Physiographic Province. Loess-mantled Kansas drift covers the surface of most of the Dissected Till Plains Section. This section is distinguished from the Young Drift Section to the north and from the Till Plains on the east by the stage it has reached in the post-glacial erosion cycle. Broadly generalized, this section is a nearly flat till plain submature to mature in its erosion cycle.

The topography at the damsite is rolling with gentle slopes and U-shaped valleys. Elevations of the ground surface range from 765 feet above M.S.L. at the damsite to 800 feet above M.S.L. approximately 0.5 mile southeast of the damsite. The reservoir slopes are in the range of 7^{o} to 13^{o} from the horizontal at the northern side, and in the range of 20^{o} from the horizontal at the eastern and southern sides of the reservoir. The reservoir slopes appear to be stable and free from any potential slide activity. The area at the damsite is covered with slope wash of glacial-fluvial deposits and loess.

The regional bedrock geology beneath the glacial outwash deposits in the damsite area as shown on the Geologic Map of Missouri (1979),(see Plate 7), consists of Pennsylvanian Pleasanton-Marmaton-Cherokee Group (cyclic deposits of shale, limestone, and sandstone). Mississippian Burlington Formation and Chouteau Group Rocks, Devonian Sulphur Springs Group consisting of Bushberg Sandstone, Glen Park Limestone, Grassy Creek Shale, and Ordovician age rocks consisting of Noix Limestone and St. Peter Sandstone.

The predominant bedrock in the site vicinity underlying the glacial fluvial deposits are the Pennsylvanian Marmaton Group rocks. Inlet and outlet areas of the unnamed tributary of the South Fork Salt River contains Quaternary alluvium.

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Kingdom City Fault nearly 12 miles south of the damsite. The Kingdom City Fault had its last movement in post-Ordovician time. Thus the fault has no effect on the damsite.

Teal Lake Dam consists of a homogeneous earthfill embankment with a corrugated metal pipe-arch spillway. Based on the available drawings, reports, conversations with Mr. Jim Manunder (Manager of Manufacturing, A. P. Green Refractories) and from the visual inspections, the embankment rests on glacial-fluvial deposits (brown, silty clay) with a core trench excavated into the glacial-fluvial deposits. The five corrugated metal pipe-arches of the spillway rest on the compacted embankment fill (reddish brown, silty clay).

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Descriptions" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Putnam-Mexico in the Central-Claypan Area family. These soils are basically formed from loess. The permeability of these soils is generally very low.

Materials were obtained from the exposed left upstream slope and abutment. Both locations were within 25 feet of either side of the concrete headwall. The materials removed appeared to be a mottled red and brown, moderately plastic, sandy to silty clay with a few fine gravels. Based on the Unified Soil Classification, the soil would probably be classified as a CL-CH. This soil type

generally has the following characteristics: impervious with a coefficient of permeability less than 50 feet per year, medium shear strength, and intermediate to high piping resistance. This soil is purportedly what was used to construct the embankment. The extent of surficial soil covering was not determined. The surficial soil known as "Missouri Flint Clay" appears to be gray, low plasticity, clayey silt with little erosonal resistance.

d. Appurtenant Structures

(1) The Spillway

On the day of the inspection, water was flowing through four out of the five pipe-arches, which hampered a comprehensive inspection; however, the majority of the interiors of each pipe was visible. The pipe on the far left side of the spillway did not have water flowing through it and a few problems were observed. A bulge on the top of the pipe was observed about midway through the conduit. It was undetermined whether the bulge was due to a failure of the pipe or the pipe was damaged during construction. The pipe to the right of this pipe also had a bulge in it but it was in the bottom of the conduit. No other pipe exhibited this problem. In the pipe on the far left side, two, 1-foot square sections of the pipe were cut out of the bottom and embankment material was exposed. It appeared that no embankment material has been transported through the pipe nor was undermining of the pipe apparent. Rusting of the pipe was also observed in the bottom of the conduit. The rust has progressed to the point where it is starting to eat through the pipe; however, no holes in the pipe were observed. This condition appears to be common in the remaining four pipes; however, the extent of deterioration could not be determined. The outlet end of the pipes extended out from the embankment from 5 to 10 feet and the pipes were unsupported for this length (see Photo 3). However, it appeared that no undermining of the outlet of the pipes has occurred and that the pipes were probably constructed this way. The headwall on the upstream end of the spillway appeared to be stable and no

major problems associated with the structure were apparent. Some erosion, due to surface runoff, was observed along the contact between the right wingwall of the headwall and the dam embankment (see Photo 10). The trashrack appeared to be secure and unobstructed. The pipe-arches were also unobstructed. No seepage was observed around the outlets of the spillway pipes.

(2) Outlet Works

There were no regulated outlet works or low level outlets constructed for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of inspection was approximately 753 feet above M.S.L.

The surface area of the reservoir at normal water level is about 67 acres. The rim seems to be stable with only one severely eroded area noted. The left abutment upstream slope is generally eroded with nearly vertical slopes up to 4 feet high. The land around the reservoir slopes gently to the rim and is grass and/or tree covered (see Photo 12). There are no homes built in close proximity to the reservoir. No evidence of excessive siltation was observed in the reservoir at the time of inspection of the reservoir.

f. Downstream Channel

The downstream channel which carries discharges from the spillway is a wide well defined channel. The channel is obstructed by tall trees and heavy vegetation (see Photo 11). These obstructions will reduce the hydraulic efficiency of the channel. The channel is approximately 25 feet wide, 4 feet deep and has a side slope of 1V to 1H on both sides.

3.2 Evaluation

The visual inspection did not uncover any items that are sufficiently significant to indicate for immediate remedial action. However, the following items were noted by the inspection team that could affect the safety of the dam and the spillway if not attended to within a reasonable period of time.

1. The severe erosion on the downstream slope, if allowed to continue, could pose a danger to the stability of the dam. The steepness of and the very sparse vegetation cover on the downstream slope also appear to be catalysis for further erosion.

2. The erosion on the left abutment contact also could have an adverse effect on the stability of the dam, if allowed to continue. The left abutment area is also fairly steep in the area of the erosion.

3. The small trees observed on the downstream slope pose a potential danger to the safety of the dam, if allowed to grow. Depending upon the extent of the root system, the roots of large trees can present possible paths for piping through the embankment. The root systems can also do damage to the embankment from being uprooted by a storm.

4. The unprotected upstream slope does not appear to affect the safety of the dam at this time. However, the slope may be subject to erosion due to surface runoff and wave action.

5. It was undetermined whether the bulges observed in the two pipes on the left side of the spillway were due to a failure of the pipes or were damaged during construction. If this condition is indeed due to a failure of the pipes, this could have an adverse effect on the structural integrity of the dam and spillway.

6. The two sections which were cut out of the bottom of the pipe on the far left side of the spillway can allow embankment material to be transported through the pipe during excessive flows through the pipe, causing a void to be created under the pipe. The holes could also allow water to flow under the pipe and cause the pipe to be undermined. Both of these conditions could lead to a collapse of the pipe and the embankment over the pipe.

7. The observed rusting of the bottom of the pipe could cause holes to develop in the pipe in which the same conditions as described above could develop, if the rusting is allowed to continue.

8. The erosion observed near the right wingwall of the headwall does not appear to affect the structural stability of the dam and spillway in its present condition.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Teal Lake Dam is used to impound water from rainfall and runoff for recreational purposes only. There are no specific procedures which are followed for the operation of the dam. The water level below the spillway crest is controlled by rainfall, runoff, and evaporation.

4.2 Maintenance of Dam

The dam is maintained by employees of A. P. Green Refractories Co. During periods of heavy rainfall, the maintenance personnel periodically check the dam. The truck haul road on the crest is also periodically maintained by A. P. Green workmen. There are, however, many trees growing on the downstream slope. The trashrack of the spillway is periodically cleaned by A. P. Green personnel.

4.3 Maintenance of Operating Facilities

There are no operating facilities associated with this dam.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system in use at the damsite.

4.5 Evaluation

The maintenance at Teal Lake Dam appears to be fair and the remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

No hydrologic and hydraulic design data is available for Teal Lake Dam. The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were based on the U.S.G.S. Mexico West and Mexico East, Missouri Quadrangle topographic maps (7.5 minute series). The spillway and overtop release rates and the reservoir elevation-area data are presented in Appendix B.

The hydrologic soil group of the watershed was determined from information available in the U.S.D.A. Soil Conservation Service publication "Missouri General Soil Map and Soil Association Descriptions", 1979. The Probable Maximum Precipitation (PMP) used to determine the Probable Maximum Flood (PMF) was determined by using the U.S. Weather Bureau publication, "Hydrometeorological Report No. 33" (April 1956).

b. Experience Data

It is believed that records of reservoir stage or spillway discharge are not maintained for this site. However, according to the representatives of the owner, the dam was overtopped by 1-1/2 feet at the lowest spot in 1970.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

Both the Probable Maximum Flood and one-half of the Probable Maximum Flood when routed through the reservoir, resulted in overtopping of the dam. The peak inflows for the PMF and one-half of the PMF are 24,908 cfs and 12,454 cfs, respectively. The peak outflow discharges for the PMF and one-half of the PMF are 24,544 and 12,190 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 1,327 cfs. The PMF overtopped the dam by 4.52 feet and one-half of the PMF overtopped the dam by 3.16 feet. The total duration of flow over the dam is 14.25 hours during the PMF and 9.25 hours during one-half of the PMF. The reservoir/spillway system of Teal Lake Dam is capable of accommodating a flood equal to approximately 12 percent of the PMF just before overtopping the dam. The reservoir/spillway system of Teal Lake Dam will not accommodate the ten percent-chance flood without overtopping. The dam embankment may be susceptible to erosion due to the high velocity of flow during overtopping.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately two miles downstream of the dam. There are two dwellings, three buildings, one railroad bridge, and a school within the damage zone.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no signs of settlement on the embankment. Items of distress include steep downstream and left abutment slopes, and severe erosion of the left abutment/embankment contact and downstream embankment face. Due to the presence of tailwater, it was not possible to ascertain if there is seepage beneath the embankment; however, there were no signs of seepage on the downstream face or around the five spillway pipes. The trees on the downstream slope are tipped downstream, which is indicative of possible surface sloughing or possible addition of fill material. In addition, the face of the reservoir rim to the left of the spillway headwall is eroded. In the absence of the seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The spillway pipe-arches appear to be stable with the exception of the bulges observed in two of the pipes. Nevertheless, it was unknown whether the condition is due to a failure of the pipes or the pipes were damaged during construction. The spillway system appears to be able to function properly.

b. Design and Construction Data

Design computations pertaining to the embankment were not available during the report preparation phase. Design drawings pertaining to the 1966 reconstruction of the dam were available and from field measurements, the dam and spillway appeared to be built accordingly. Nevertheless, the design drawings were of limited use

in assessing the structural stability of the dam and the spillway. Seepage and stability analyses comparable to the requirements of the "Recommended Guidleines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records were available relating to the dam or appurtenant structures. The water level on the day of the visual inspection was approximately one inch above the spillway crest. The spillway crest is considered to be the normal operating level; however, the dam has been overtopped by approximately 1-1/2 feet during a flood in 1970. The reservoir would normally be controlled at the level of the crest of the spillway.

d. Post Construction Changes

Several post construction changes to the reconstructed embankment (1966) have been made which could have some affect on the structural stability of the dam and spillway. In 1967 and 1969, remedial measures were undertaken to prevent leakage around the corrugated metal pipe-arches. The measures taken were pressure grouting around the pipes in 1967, which required additional grouting in 1969 to fill voids around the pipes, and in 1967 a sheet piling wall was provided upstream of the pipes as a cutoff wall. The concrete apron which was placed under the pipes and extended out to the sheet piling, was also constructed at the same as the sheet piling wall. According to Mr. Dennis Hammen, the piles were driven into the hard, clay foundation of the dam at a depth of 20 to 25 feet. The concrete headwall was placed at the upstream end of the spillway in 1969. All of these remedial measures appear to have been beneficial to the structural stability of the dam and the

spillway. The grouting operations and sheet piling wall appear to have stopped the leakage, which was a problem in 1967 and 1969 and has prevented further leakage. All of these remedial measures are shown on Plates 3 and 4 as revisions. No other post construction changes are known to exist.

e. Seismic Stability

The dam is located in Seismic Zone 1 (see Plate 9), as defined in "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers, and will not require a seismic stability analyses. An earthquake of the magnitude that would be expected in Seismic Zone 1 will not cause significant distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the dam site.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigations, testing and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Teal Lake Dam is found to be "Seriously Inadequate". The reservoir/spillway system will accommodate approximately 12 percent of the PMF without overtopping the dam. The surface soils in the embankment appear to be clayey silt. The dam embankment is not protected against erosion. The dam is overtopped by 4.52 feet during the occurrence of the PMF. The dam may be susceptible to erosion due to overtopping of the dam during the PMF and one-half of the PMF.

The dam appears to be in poor condition. The downstream face and left abutment area pose a serious problem. Indications are that surficial sloughing of the slopes is an ongoing event. The hazard posed is that if a major slope failure in either of these areas should occur, the event would probably result in blocking of the spillway conduits. In addition, the deep erosion channels reduce the safety factor for the respective slopes. A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment and appurtenant structures, however, reportedly have performed satisfactorily since their reconstruction; there have been no failures. The dam was overtopped by 1-1/2 feet at the lowest spot in 1970. The safety of the dam can be improved if the deficiencies described in Sections 3.2 and 6.1a and above are properly corrected as described in Section 7.2.

b. Adequacy of Information

The conclusions presented in this report are based upon field measurement, past performance and the present condition of the dam. Some information on the design of the dam was available, and this information was considered good. However, the design drawings were of limited use in the assessment of the overall safety of the dam and the spillway. Some data from this information were used for Phase I hydrologic and hydraulic evaluation of the dam. However, seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time, and the item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, a Phase II inspection is not felt to be necessary.

7.2 <u>Remedial Measures</u>

a. Alternatives

One of the following mitigation measures should be undertaken to avoid severe consequences of dam failure from overtopping.

1. Increase the spillway capacity to pass the Probable Maximum Flood without overtopping the dam.

2. Increase the height of the dam enough to pass the PMF without overtopping the dam. An investigation should also be done that includes studying the effects of increasing the height of the dam on the structural stability of the embankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. The erosion on the downstream slope and the left abutment should be properly protected from further damage.

2. Reduce the downstream embankment and left abutment slopes to not less than 1V to 2H which could also help alleviate the erosional problems.

3. Provide a protective cover, such as seeding with grass, on the embankment and abutment areas which will improve the erosion resistance to surface runoff.

4. Clear the small trees from the downstream slope and prevent them from growing back on the slope. The clearing of the trees should be done under the supervision of an engineer experienced in the design and construction of earth dams.

5. The upstream slope should also be adequately protected from surface runoff and wave action.

6. Monitor the bulges observed in the two pipes of the spillway to determine the cause of the bulges. If they are due to a failure of the pipes, corrective measures should be taken to control the situation.

7. Protective measures should be taken to protect the two areas of exposed embankment inside the pipe on the far left side of the spillway where the one-foot square sections of the pipe were removed. It should also be determined whether the same condition exists in the remaining four pipes.

8. The rusting in the bottom of the pipes should be properly repaired and protected from further deterioration.

9. The erosion along the contact between the right wingwall of the headwall and the embankment should be backfilled and the area properly protected from further damage.

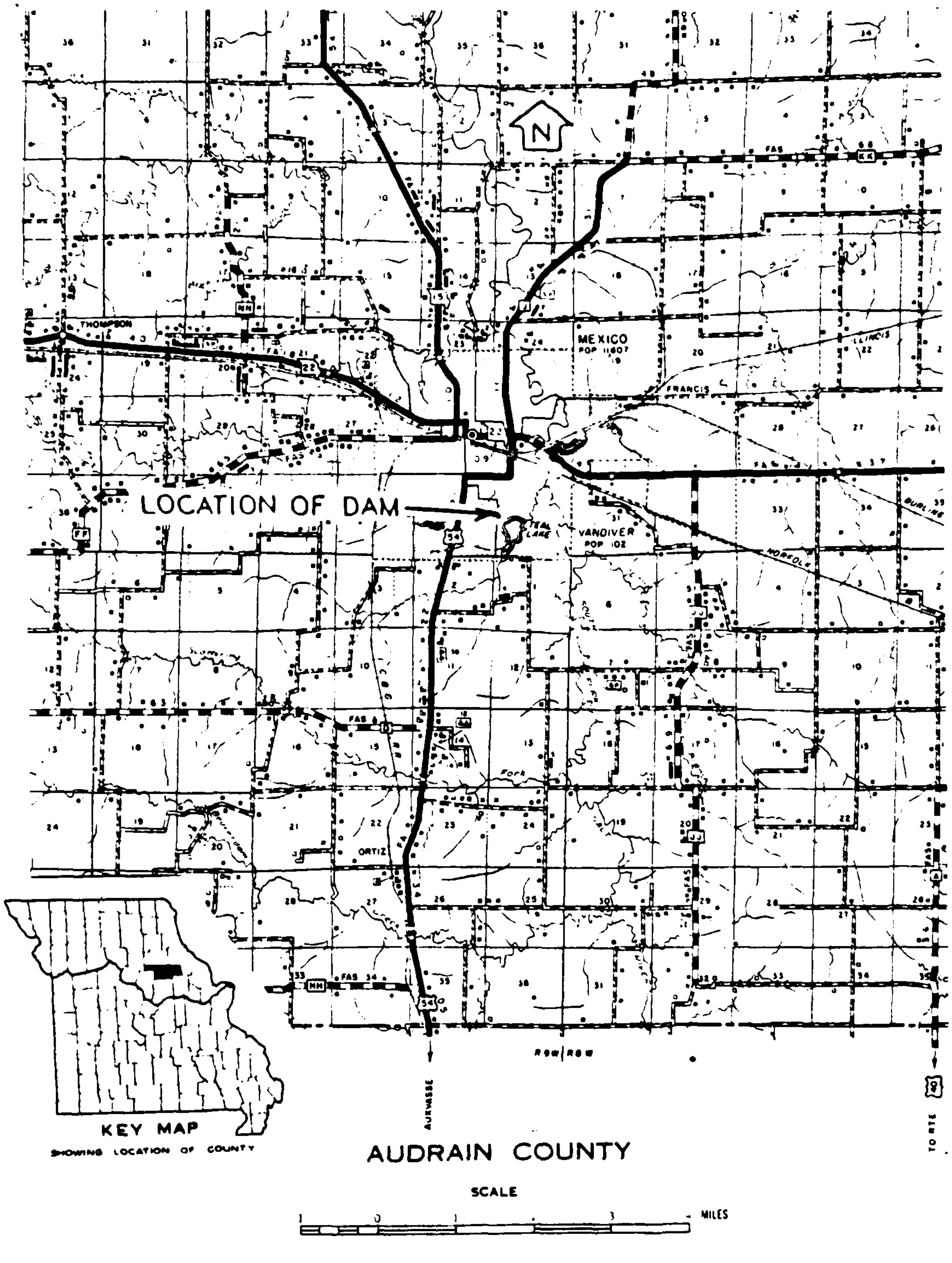
10. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

11. The owner should initiate the following programs:

    (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

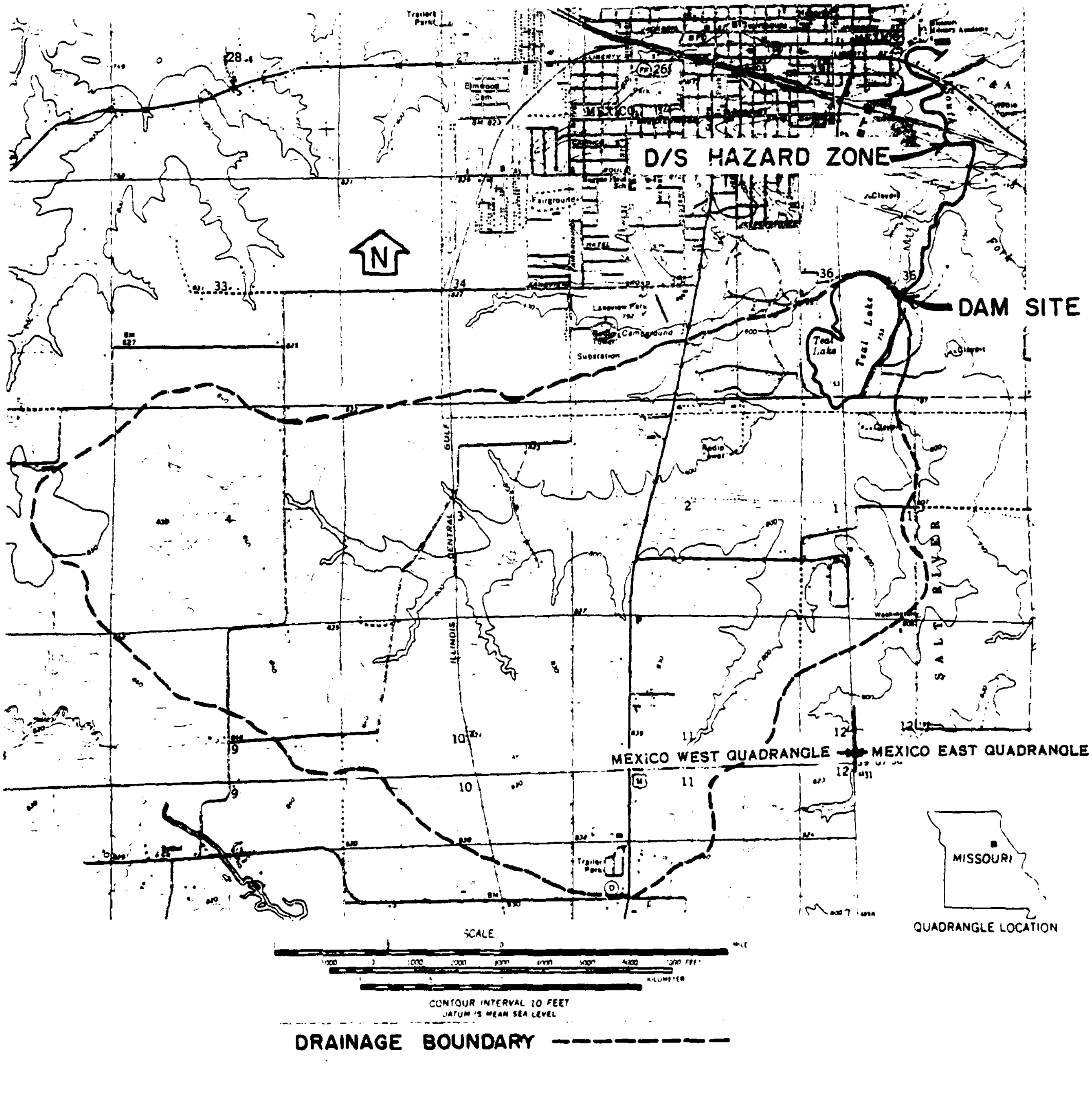
    (b) Set up a maintenance schedule and log all visits to te dam for operation, repairs and maintenance.

PLATES

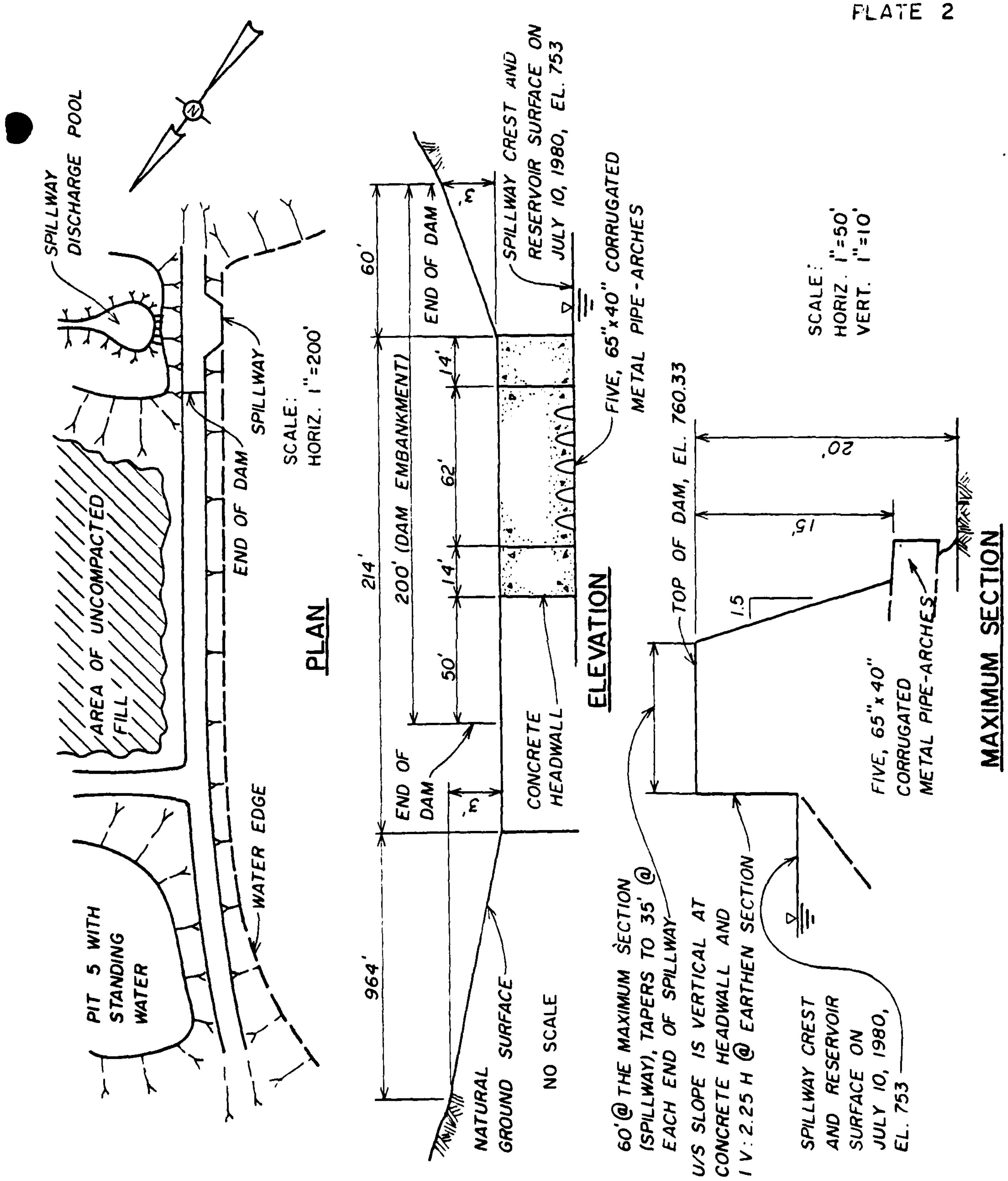


LOCATION MAP — TEAL LAKE DAM

MO. 10082

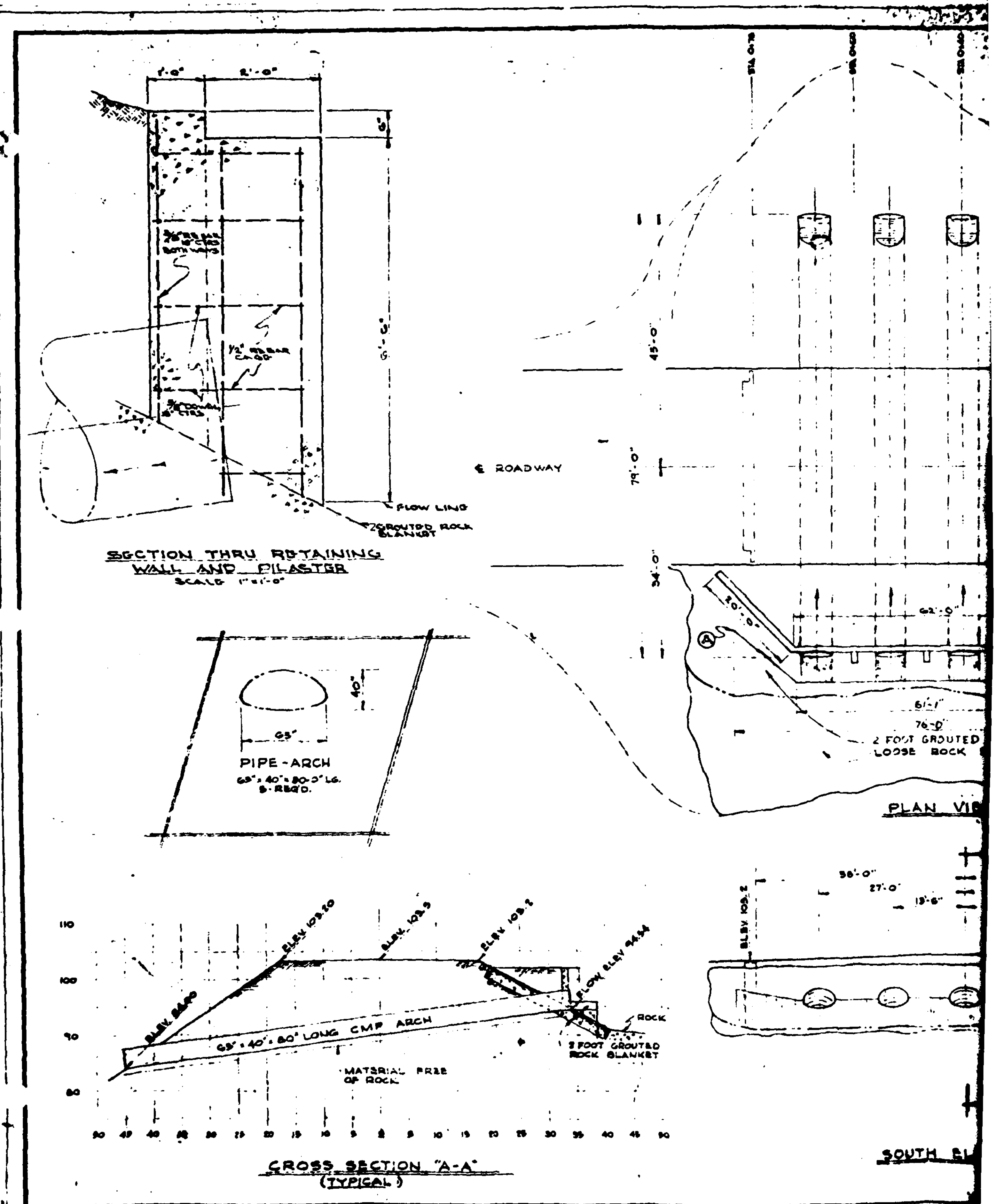


TEAL LAKE DAM (MO. 10082)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE

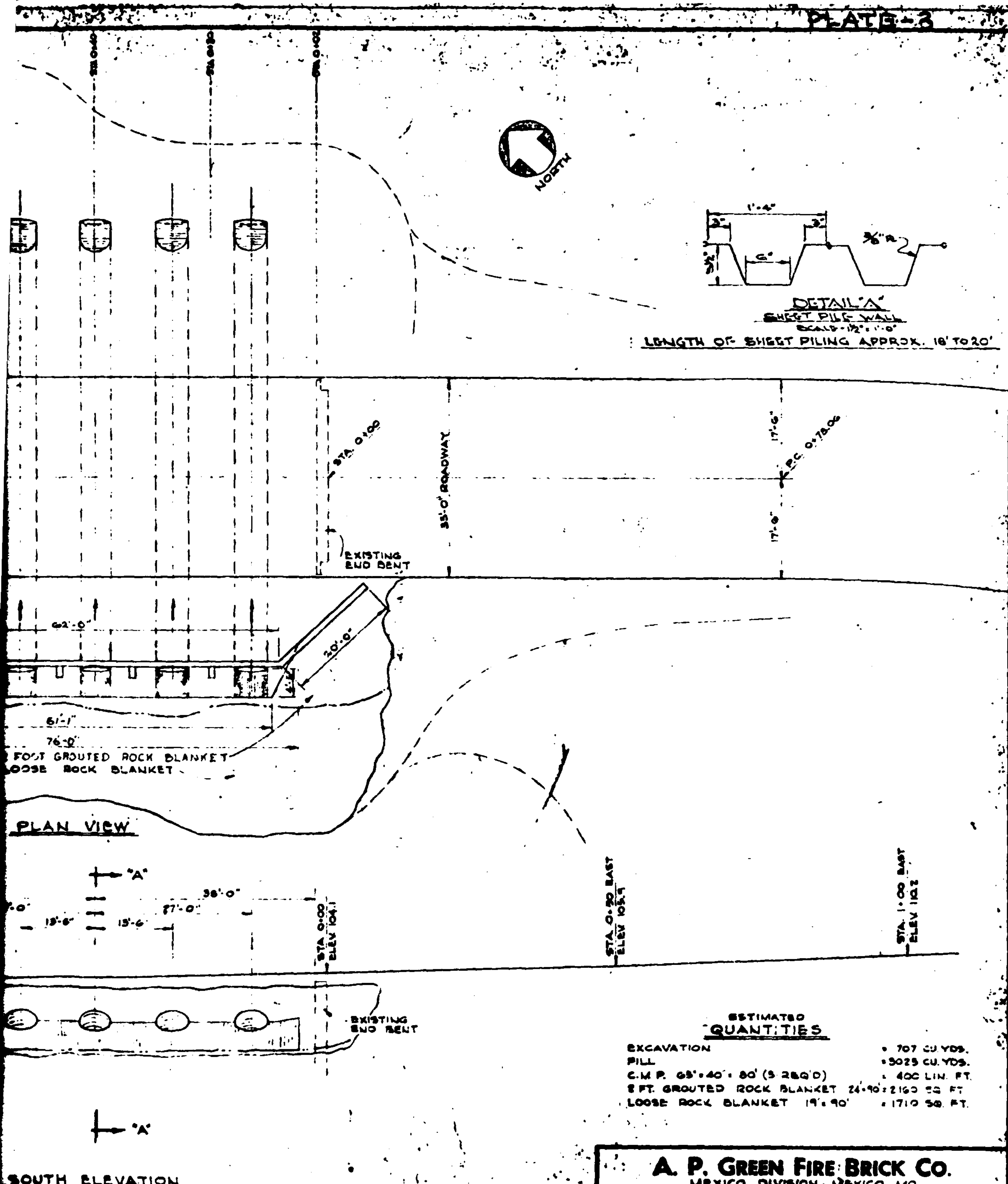


NOTE: ALL ELEVATIONS ARE SHOWN AS FEET ABOVE M.S.L.

TEAL LAKE DAM (MO. 10082)
PLAN, ELEVATION &
MAXIMUM SECTION OF EMBANKMENT



REDESIGNED & REDRAWN 8-11-66 D.T.H. REV-1	ADDED SHEET PILE WALL 6-3-68 J.D. REV-2	ADDED RETAINING WALL 10-16-68 REV-3	REV-4



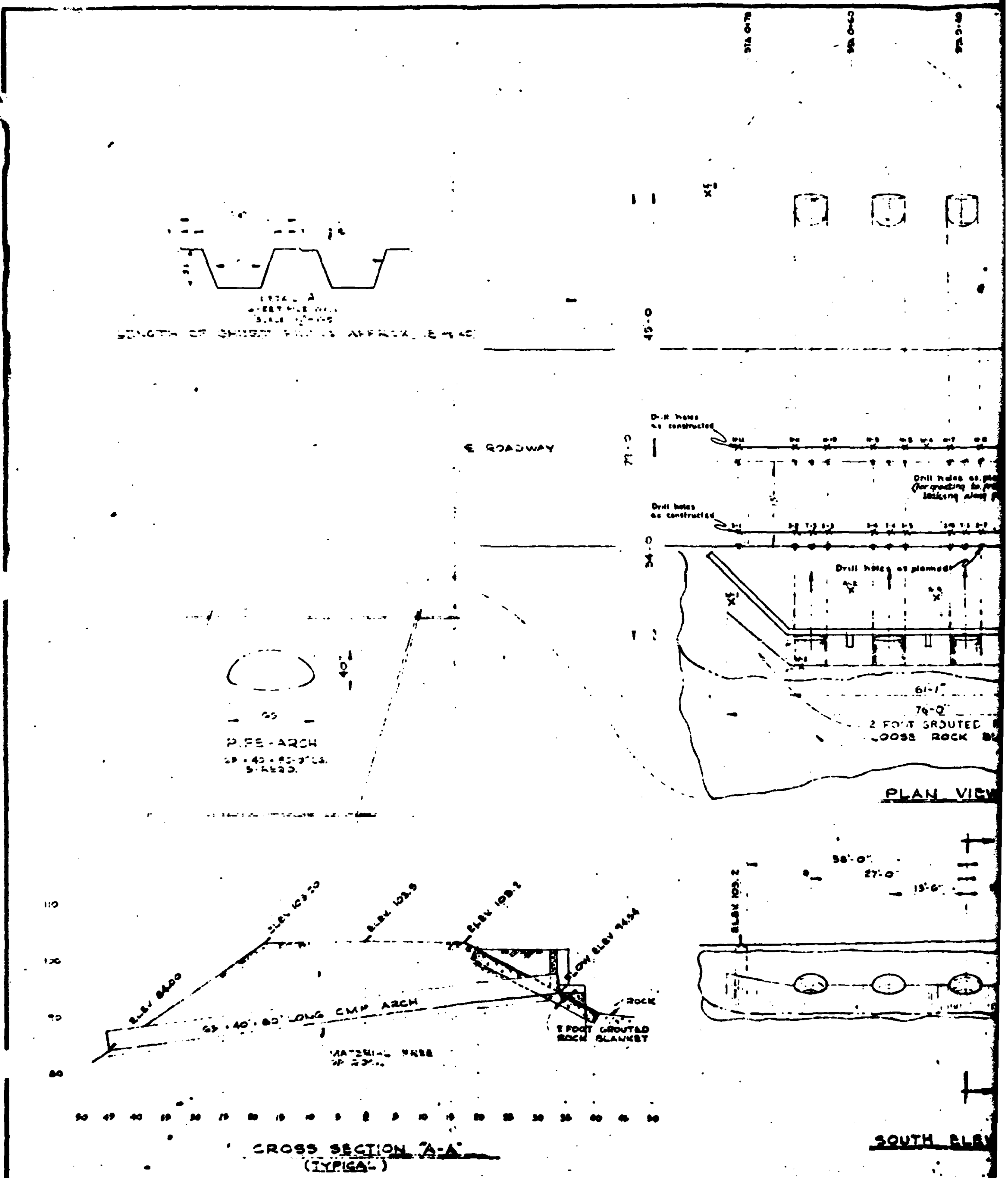
ESTIMATED
QUANTITIES

EXCAVATION	= 707 CU. YDS.
FILL	= 3025 CU. YDS.
C.M.P. 65'+40'+80' (3 REQ'D)	= 400 LIN. FT.
2 FT. GROUTED ROCK BLANKET 24'×90'	= 2160 SQ. FT.
LOOSE ROCK BLANKET 19'×90'	= 1710 SQ. FT.

A. P. GREEN FIRE BRICK CO.
MEXICO DIVISION · MEXICO, MO.

TEAL LAKE DAM & SPILLWAY

DWG. No. 110-HIS-24-3

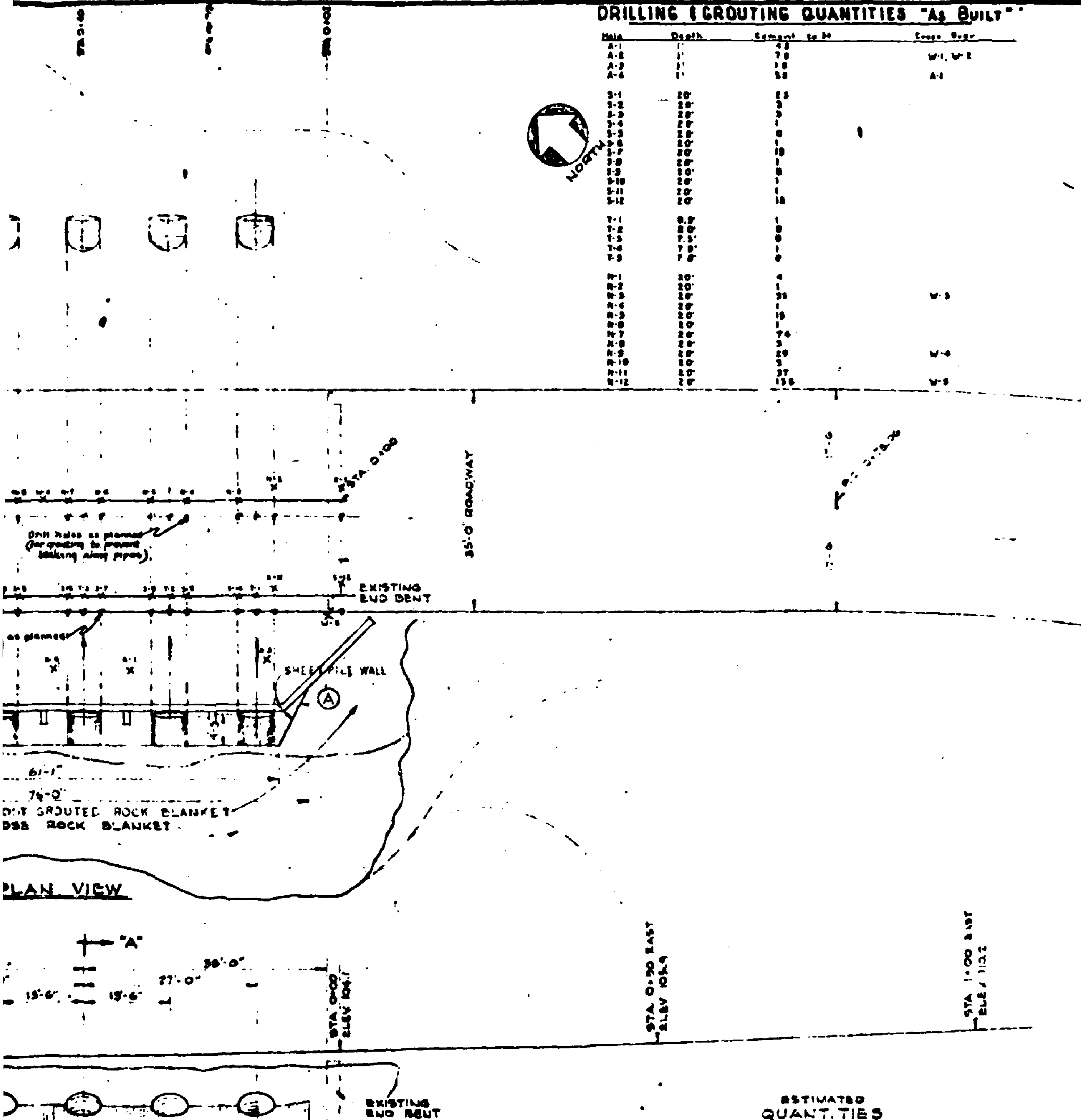


REDESIGNED & REDRAWN | ADDED SHEET PILE WALL | ADDED RETAINING WALL 10-16-69

PLATE-4

DRILLING & GROUTING QUANTITIES "As Built"

Hole	Depth	Cement cu ft	Cross Over
A-1	1'	48	
A-2	1'	78	W-1, W-2
A-3	1'	18	
A-4	1'	58	A-1
S-1	20'	23	
S-2	20'	3	
S-3	20'	3	
S-4	20'	1	
S-5	20'	0	
S-6	20'	1	
S-7	20'	19	
S-8	20'	1	
S-9	20'	0	
S-10	20'	1	
S-11	20'	1	
S-12	20'	15	
T-1	8.5'	1	
T-2	8.0'	0	
T-3	7.5'	0	
T-4	7.0'	1	
T-5	7.0'	0	
R-1	20'	4	
R-2	20'	1	
R-3	20'	35	W-3
R-4	20'	1	
R-5	20'	15	
R-6	20'	1	
R-7	20'	74	
R-8	20'	3	
R-9	20'	29	W-4
R-10	20'	3	
R-11	20'	37	
R-12	20'	136	W-5



ESTIMATED QUANTITIES

EXCAVATION	= 707 CU YDS
FILL	= 2325 CU YDS.
C.M.P. 65'+40+80' (3 REQD)	= 400 LIN. FT
2 FT. GROUTED ROCK BLANKET 24×90'	= 2160 SQ FT
LOOSE ROCK BLANKET 19'×90'	= 1710 SQ FT

Revised Aug 18, 1969

Drilling	: 510 ft	Grouting	: 288 cu ft
Cement	: 236 sks	Pressure tests	: 34 each
Bentonite	: 2000 lbs	Connections	: 58 each

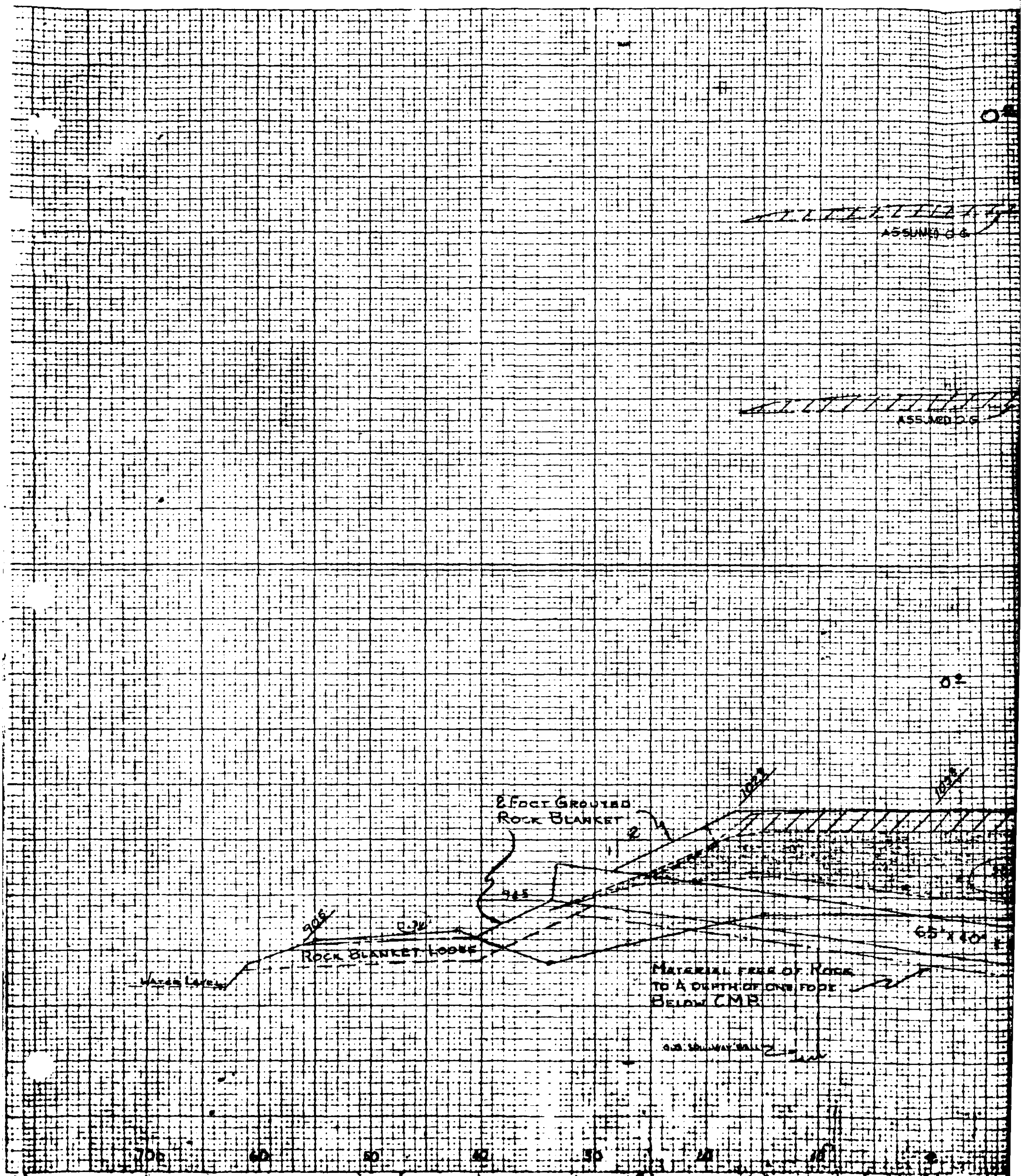
Revised 8-18-69
BERNARD G. BROWNING
Professional Engineer & Land Surveyor
Fulton, Missouri

SOUTH ELEVATION

A. P. GREEN FIRE BRICK CO.
MEXICO DIVISION - MEXICO, MO.

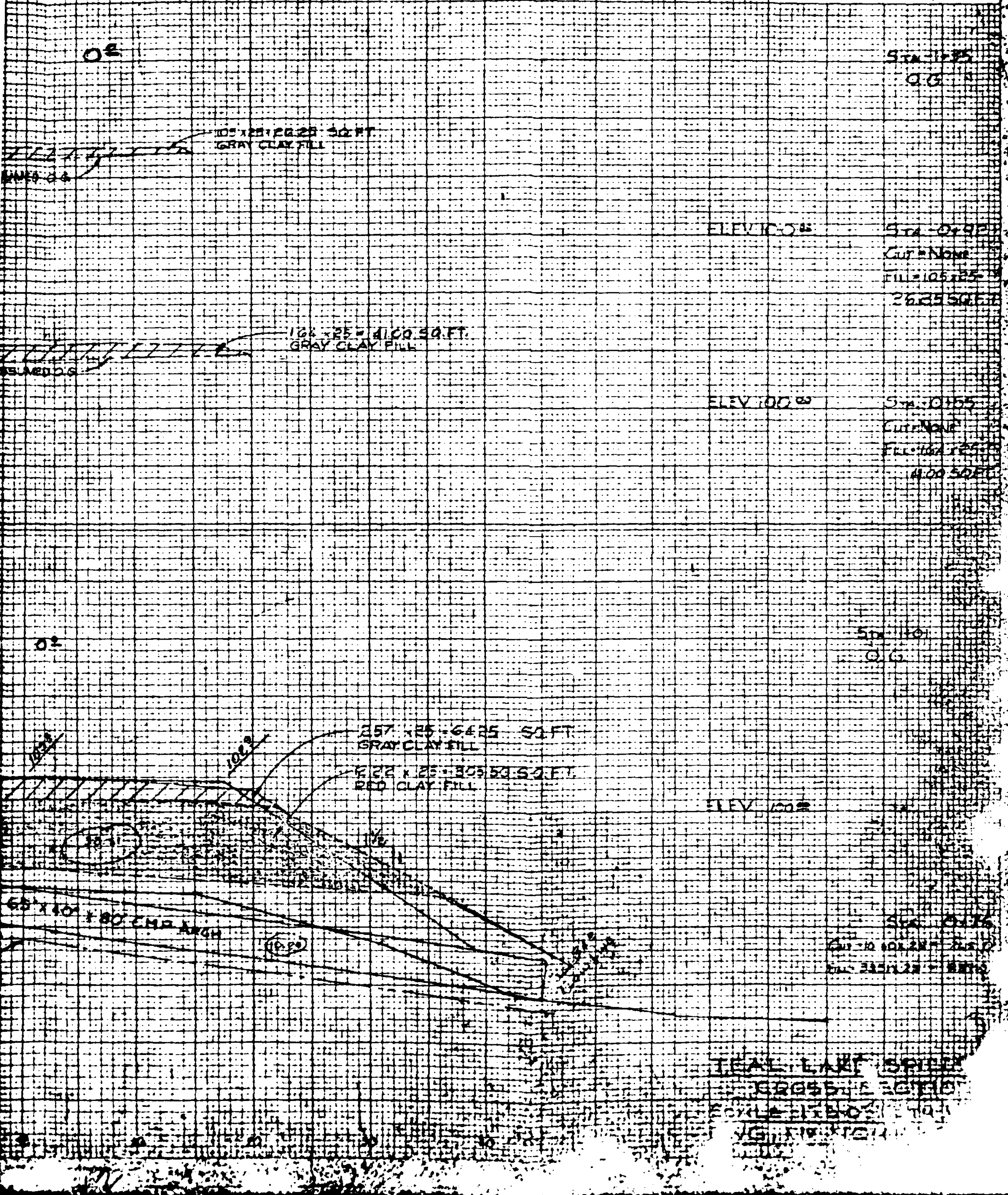
TEAL LAKE DAM & SPILLWAY

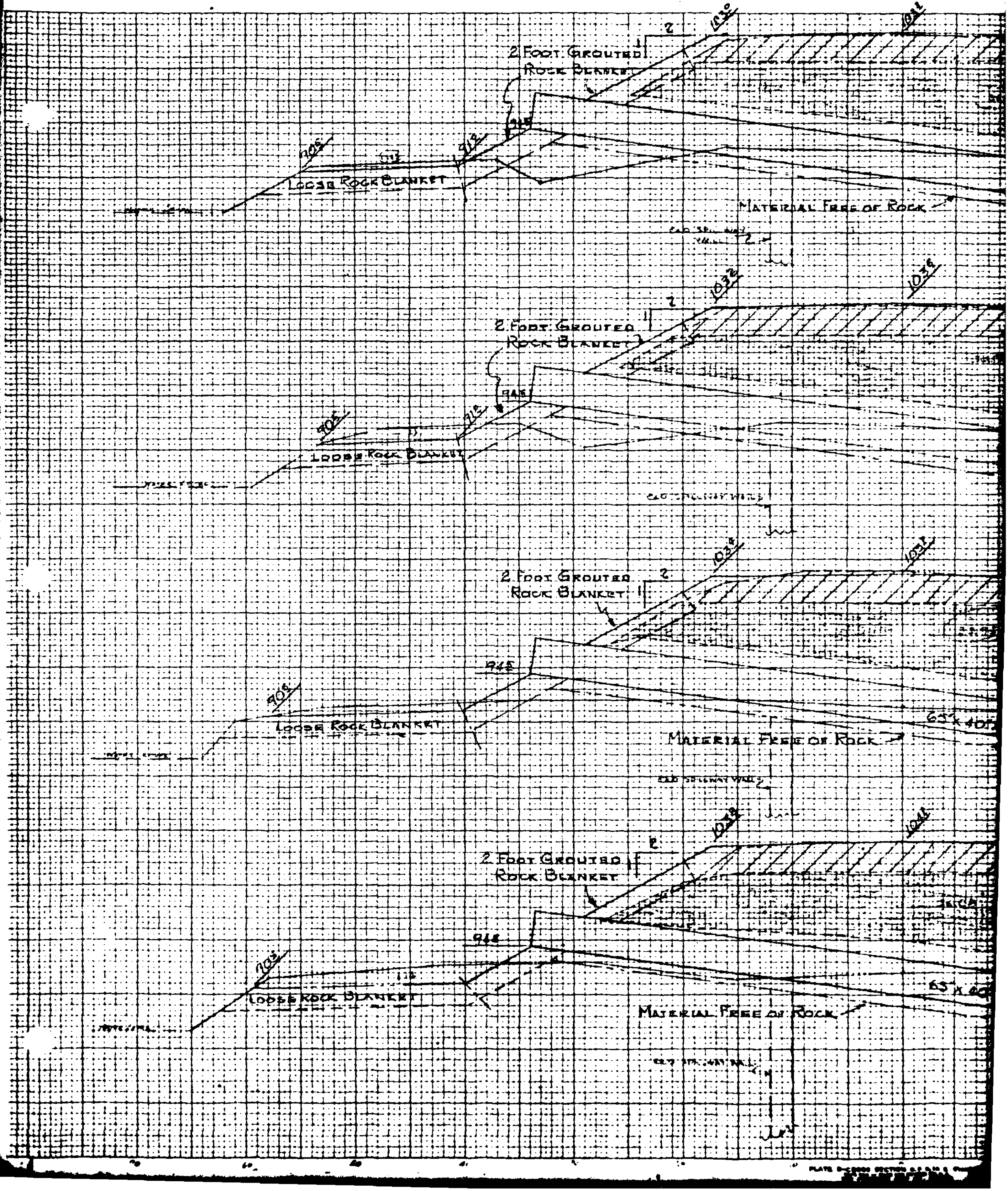
SHEET No. 2 DWG. No. 110 HIS-24-8



ASSUMED O.G.
ASSUMED O.G.
2 FOOT GROUTED
ROCK BLANKET
945
906
ROCK BLANKET LOOSE
WATER LEVEL
65' x 40'
MATERIAL FREE OF ROCK
TO A DEPTH OF ONE FOOT
BELOW CMB
70
60
50
40
30
20
10

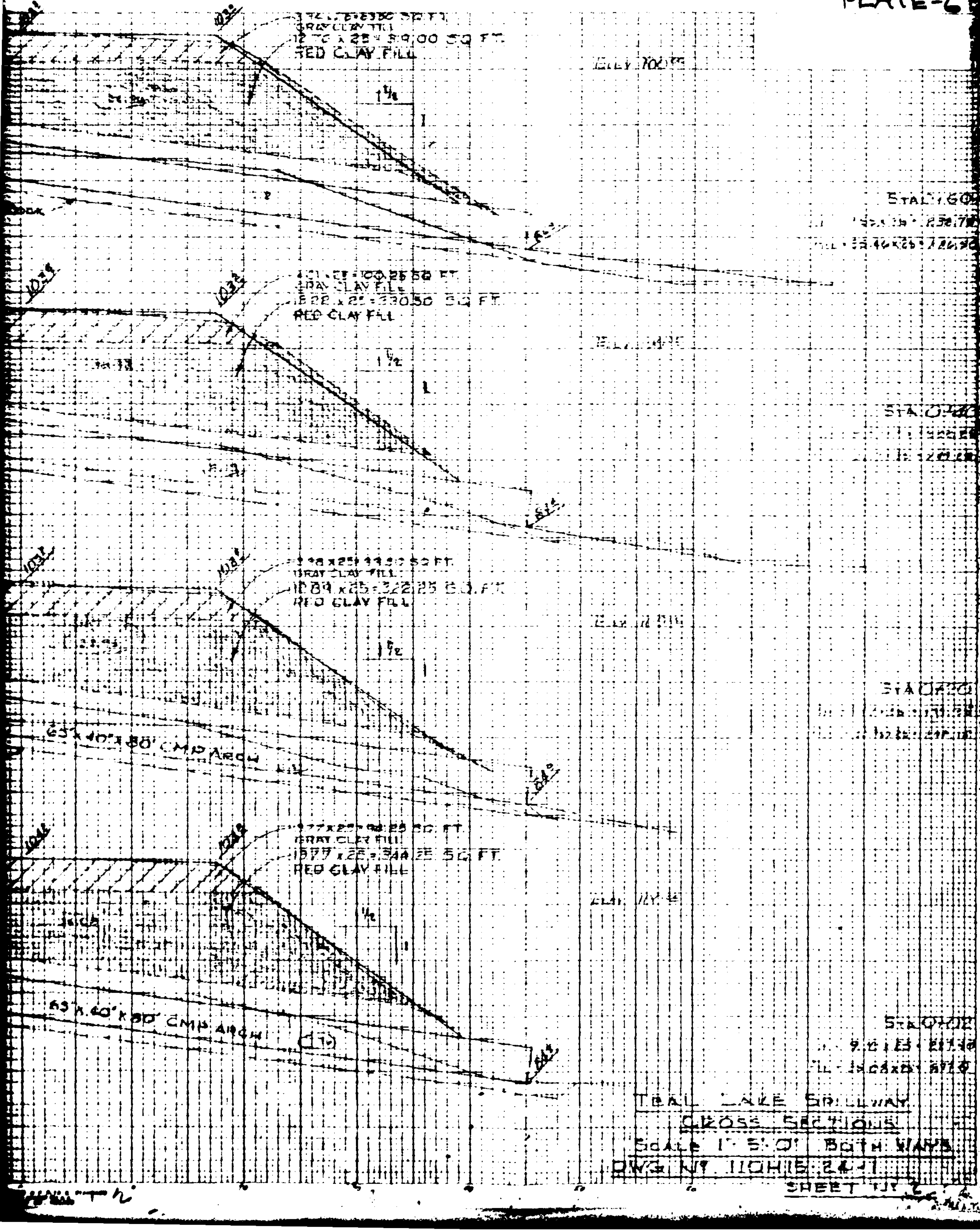
PLATE-5

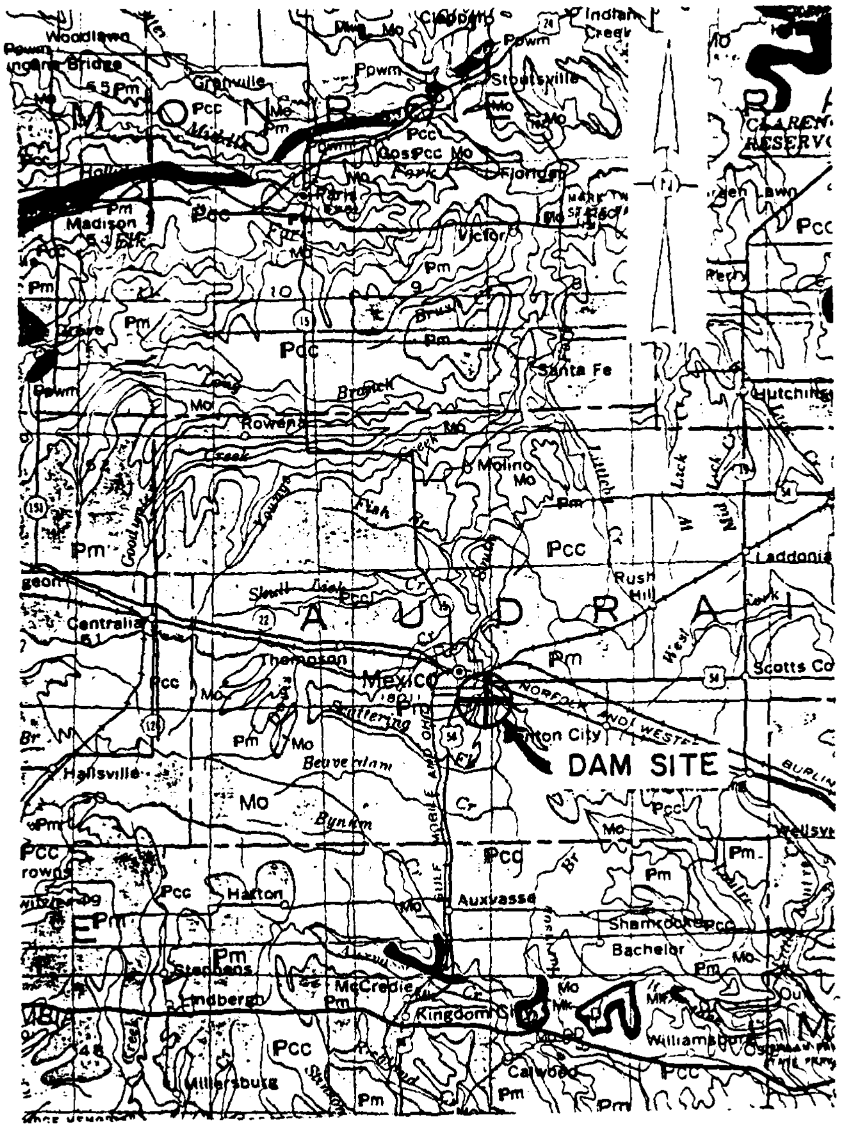

105 x 25 = 26.25 SQ. FT.
GRAY CLAY FILL
STA. 1+25
O.G.
ELEV. 105
STA. 0+92
CUT = NONE
FILL = 105 x 25 =
26.25 SQ. FT.
164 x 25 = 41.00 SQ. FT.
GRAY CLAY FILL
ELEV. 100
STA. 0+55
CUT = NONE
FILL = 164 x 25 =
41.00 SQ. FT.
STA. 1+01
O.G.
257 x 25 = 64.25 SQ. FT.
GRAY CLAY FILL
RED CLAY FILL
ELEV. 100
65' x 40' x 80' CMP ARCH
TEAL LAKE SPILLWAY
CROSS SECTION



2 Foot Grouted Rock Blanket
Loose Rock Blanket
Material Free of Rock
905
918
948
1030
1032
2 Foot Grouted Rock Blanket
Loose Rock Blanket
905
918
948
1032
1036
2 Foot Grouted Rock Blanket
Loose Rock Blanket
Material Free of Rock
905
948
1032
1036
2 Foot Grouted Rock Blanket
Loose Rock Blanket
Material Free of Rock
905
948
1038
1042

PLATE-6


GRAY CLAY FILL
RED CLAY FILL
GRAY CLAY FILL
RED CLAY FILL
GRAY CLAY FILL
RED CLAY FILL
65" x 40" x 80' CMP ARCH
GRAY CLAY FILL
RED CLAY FILL
65" x 40" x 80' CMP ARCH
TEAL LAKE SPILLWAY
CROSS SECTIONS
SHEET NO 2



SCALE

10 0 10 20 30 40 Miles

⊕ LOCATION OF DAM

NOTE: LEGEND OF THIS DAM IS ON PLATE 8

REFERENCE:

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF TEAL LAKE DAM

TEAL LAKE DAM
PLATE 8

LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	PPwm	PLEASANTON GROUP: CYCLIC DEPOSITS OF SANDSTONE, SHALE AND LIMESTONE
	Pm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	Pcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
MISSISSIPPIAN	Mo	KEOKUK - BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	CHOUTEAU GROUP: COMPTON AND BACHELOR FORMATION (LIMESTONE AND SHALE)
DEVONIAN	D	SULPHUR SPRING GROUP: BUSHBERG SANDSTONE GLEN PARK LIMESTONE, GRASSY CREEK SHALE
ORDOVICIAN	Ou	NOIX LIMESTONE
	Osp	ST. PETER SANDSTONE

APPENDIX A

PHOTOGRAPHS

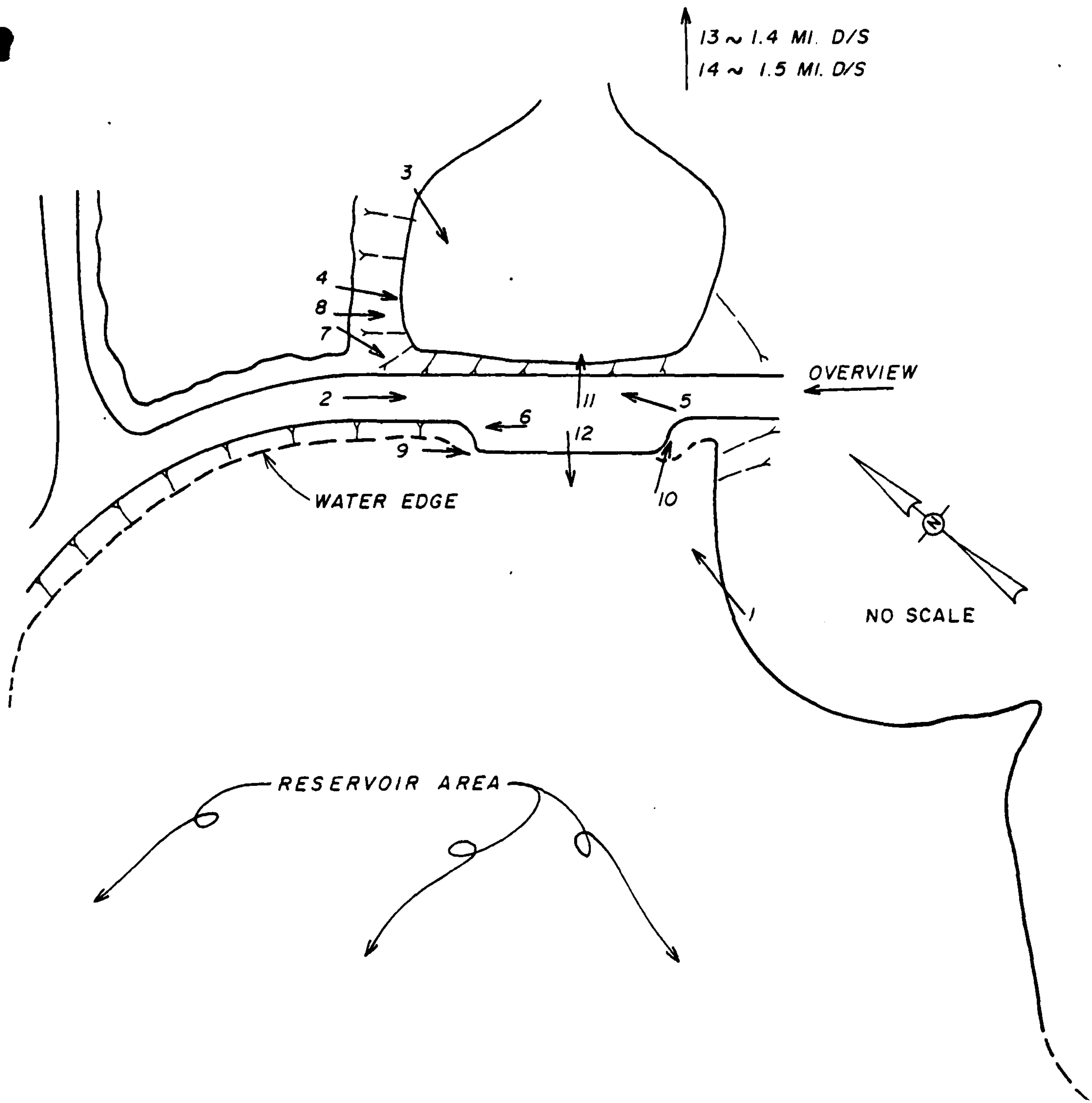


PHOTO INDEX
FOR
TEAL LAKE DAM

Teal Lake Dam

Photographs

Photo 1	-	View of the upstream slope showing the entrance to 5 corrugated metal pipe-arches.
Photo 2	-	View of the top of dam.
Photo 3	-	View of the downstream slope showing the erosion on the slope and the outlet ends of the pipe-arches.
Photo 4	-	View of the downstream slope showing the growth of vegetation on the right side of the embankment.
Photo 5	-	View across the top of dam showing the downstream area of the left abutment.
Photo 6	-	View of the upstream slope to the left of the spillway.
Photo 7	-	View of the surface runoff erosion on the left side of the embankment looking back toward the reservoir.
Photo 8	-	View of the erosional gully in Photo 7 as it turns and heads toward the downstream channel.
Photo 9	-	View of the entrance to the 5 corrugated metal pipe-arches showing the trashrack and the retaining wall.
Photo 10	-	View of the erosion along the contact of the right wingwall of the retaining wall and the embankment.
Photo 11	-	View of the downstream channel.
Photo 12	-	View of the reservoir and rim.

Photo 13 - View of several buildings believed to be in the downstream hazard zone with the downstream channel in the background.

Photo 14 - View of the Military school believed to be in the downstream hazard zone with the downstream channel to the right of the photo.

Photo 1

Photo 2

Photo 3

Photo 4

Photo 5

Photo 6

Teal Lake Dam

Photo 8

Photo 7

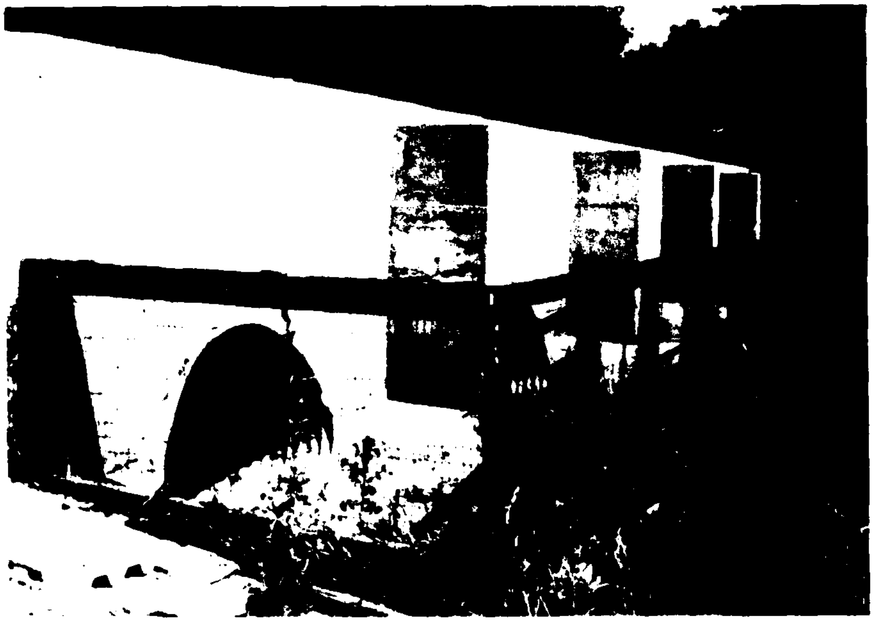


Photo 9

Photo 10

Photo 11

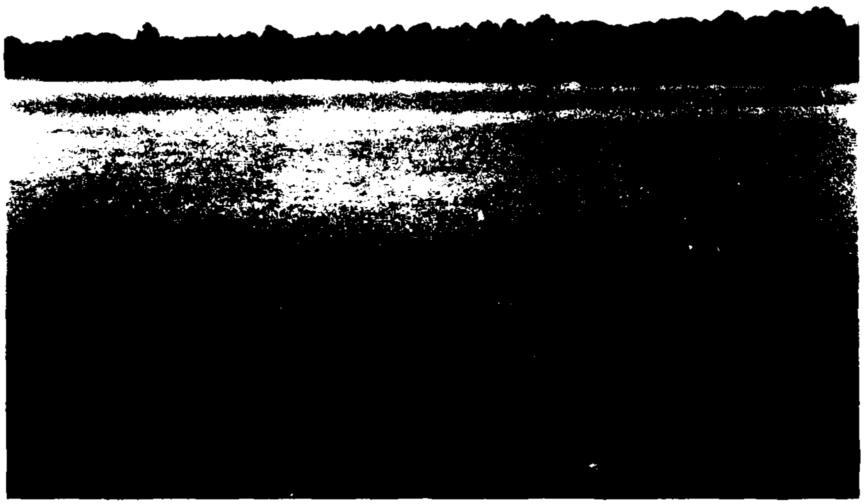


Photo 12

Photo 13

Photo 14

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

TEAL LAKE DAM

HYDROLOGIC AND HYDRAULIC DATA, ASSUMPTIONS AND METHODOLOGY

1. SCS Unit Hydrograph and HEC-1DB are used to develop the inflow hydrographs, and the hydrologic inputs are as follows:

   (a) Twenty-four hour probable maximum precipitation from Hydrometeorological Report No. 33, 48-hour 100-year rainfall and 48-hour 10-year rainfall of Moberly, Missouri.

   (b) Drainage area = 6.43 square miles.

   (c) Lag time = 1.55 hours.

   (d) Hydrologic Soil Group:
   Soil Group "D"

   (e) Runoff curve number:
   CN = 83 for AMC II and CN = 93 for AMC III.

2. Spillway release rates are based on pipe flow assuming Manning's n = -0.025. Flow rates over the dam are based on broad crested weir equation $Q = CLH^{3/2}$.

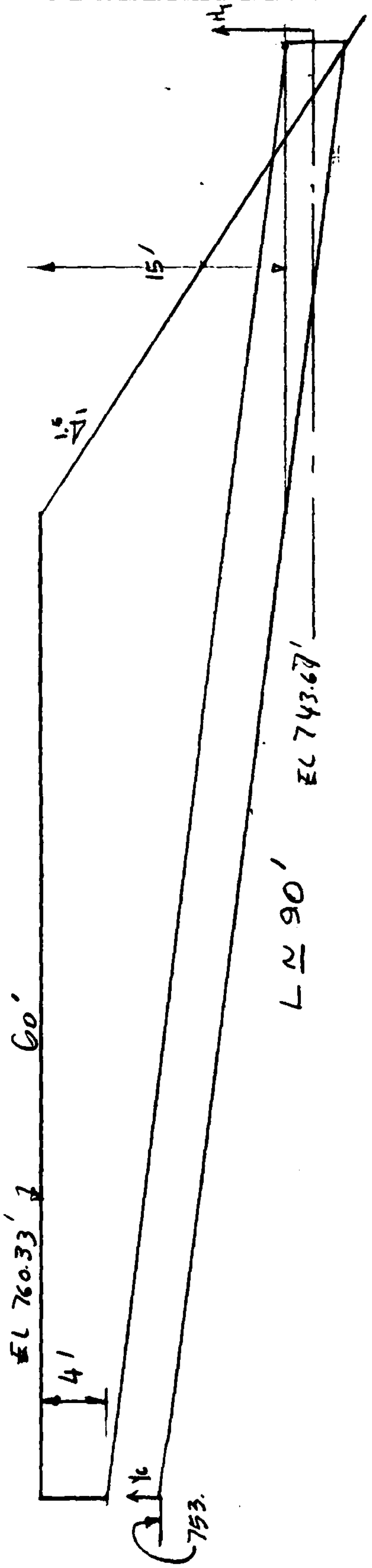
3. Floods are routed through Teal Lake to determine the capability of its spillway.

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. ____ OF ____

TEAL LAKE DAM (MO 10882) — JOB NO. ____

SPILLWAY RATING CURVE — BY DC — DATE 7/22/80



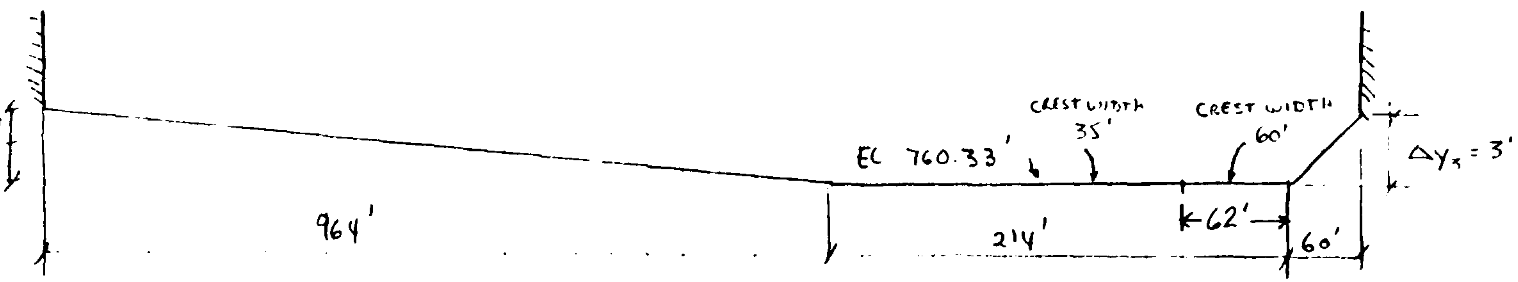
H_T = WSEL − 743.67

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO ___ OF ___

TEAL LAKE DAM (MO 10082) — JOB NO ___

OVERTOP RATING CURVE — BY DC — DATE 7/22/80

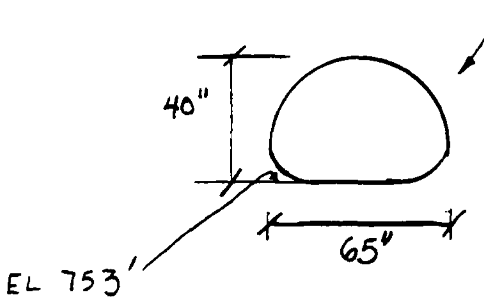


WSEL	H_1	C_1	L_1	$Q_1 = C_1 L_1 H_1^{3/2}$	$y_2 = \frac{2}{3}\left(H_1 + \frac{\Delta y_2}{4}\right)$	A_2	T_2	$Q_2 = \sqrt{\frac{A_2^3 g}{T_2}}$	$y_3 = \frac{2}{3}\left(H_1 + \frac{\Delta y_3}{4}\right)$	T_3	A_3	$Q_3 = \sqrt{\frac{A_3^3 g}{T_3}}$	C_4	L_4	$Q_4 = C_4 L_4 H^{3/2}$	$Q_T = Q_1 + Q_2 + Q_3 + Q_4$
760.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
760.63	.3	2.99	62'	30.45	.24	9.25	77.12	18.19	.24	4.8	.58	1.13	2.99	152'	74.65	124
760.93	.6	3.03	62	87.23	.48	37.0	154.24	102.91	.48	9.6	2.3	6.40	3.03	152	213.86	410
761.33	1.0	3.04	62	188.17	.8	102.8	257.1	369.03	.80	16.0	6.4	22.97	3.04	152	461.32	1041
761.63	1.3	3.04	62	279.28	1.04	173.8	334.2	711.09	1.04	20.8	10.82	44.26	3.04	152	684.68	1719
761.83	1.5	3.04	62	346.39	1.20	231.4	385.6	1016.93	1.20	24.0	14.4	63.29	3.04	152	849.22	2276
762.13	1.8	3.04	62	455.76	1.44	333.16	462.72	1604.15	1.44	28.8	20.74	99.84	3.04	152	1117.35	3277
762.33	2.0	3.05	62	534.07	1.60	411.31	514.13	2087.56	1.60	32.0	25.60	129.73	3.05	152	1309.34	4061
762.63	2.3	3.05	62	659.10	1.84	543.95	591.25	2960.62	1.84	36.8	33.86	184.27	3.05	152	1615.86	5420
763.03	2.7	3.05	62	838.98	2.16	749.61	694.08	4420.52	2.16	43.2	46.66	275.14	3.05	152	2056.82	7592
763.33	3.0	3.05	62	983.15	2.40	925.44	771.2	5782.64	2.40	48.0	57.6	358.05	3.05	152	2410.29	9504
763.83	3.5	3.05	62	1237.86	2.80	1259.6	899.7	8457.34	2.80	56.0	78.4	526.37	3.05	152	3013.66	13263
764.33	4.0	3.06	62	1515.83	3.167	1606.67	964	11770.04	3.17	60	100	732.58	3.06	152	3716.23	17735
764.83	4.5	3.06	62	1809.82	3.50	1928.0	964	15972.12	3.50	60	120	963.0	3.06	152	4436.98	22682
765.33	5.0	3.06	62	2120.80	3.83	2249.3	964	19497.1	3.83	60	140	1213.51	3.06	152	5199.37	28031
766.33	6.0	3.06	62	2790	4.50	2892	〃	28424	4.50	60	180	1769	3.06	152	6835	39818

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. ___ OF ___

TEAL LAKE DAM (MO 10082) — JOB NO. ___

SPILLWAY RATING CURVE — BY DC / KLB — DATE 7/22/80



ARCH PIPE, 65" x 40" x 90' CMP

5 Pipes

For flows before pressure flow and assuming critical depth we have:

Total area of pipe = 14.3 ft^2

Y_c	A_c *1	Q_c *2	V_c	$V_c^2/2g$	WSEL
1	4.0 ft^2	25	6.25	.61	754.6
1.2	5.15	33	6.41	.64	754.84
1.4	6.44	45	6.99	.76	755.16
1.6	7.51	56	7.46	.86	755.46
1.8	9.0	68	7.56	.89	755.69
2.0	10.01	82	8.19	1.04	756.04
2.2	10.87	95	8.74	1.19	756.38
2.4	11.73	112	9.55	1.42	756.81
2.6	12.58	130	10.33	1.66	757.25
2.8	13.23	150	11.34	2.00	757.79
3.0	13.73	180	13.11	2.67	758.67
3.2	14.01	208	14.85	3.42	759.62

*1 Obtained from "Proportional Values Based on Full Conditions" graph, Handbook of Steel Drainage and Highway Construction Products, pg. 170, AISI

*2 Obtained from - AISI book pg. 185

For pressure flow we have

$K_e = 0.5$ (entrance coefficient) $K_v = 1.0$ (EXIT LOSS)

$K_c = \frac{29.16 n^2}{r^{4/3}}$ $r = 1.012$ * from AISI book pg 170

$n = .025$ $L = 90'$

$A = 14.3$

$K_c = \frac{29.16(.025)^2}{1.012^{4/3}} = .0179$ $K_c L = 1.6$ $L = 90$

$$Q = A\sqrt{\frac{2gH_T}{1 + K_e + K_c L}} = 14.3\sqrt{\frac{64.4 H_T}{3.1}} = \underline{65\sqrt{H_T}}$$

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. ____ OF ____

TEAL LAKE DAM (MO 10082) — JOB NO. 1263

COMBINED RATING CURVE — BY D C / RLB — DATE 7/22/80

Datum: 743.67 for pressure flow

5 PIPES

Reservoir Water Surface Elev.	H_T	x5 ~~Principal~~ Spillway Discharge $Q = 65\sqrt{H_T}$	Emergency Spillway Discharge	Discharge Over Top of Dam	Combined Discharge
753.0	—	0		—	0
754.6	—	125.0		—	125
755.16	—	225		—	225
755.69	—	340		—	340
756.38	—	475		—	475
757.79	—	750		—	750
759.62	—	1040		—	1040
760.33	16.66	1327		—	1327
760.63	16.96	1339		124	1463
760.93	17.26	1350		410	1761
761.33	17.67	1366		1041	2407
761.93	18.17	1385		2276	3661
762.33	18.67	1404		4061	5465
763.03	19.37	1430		7592	9022
763.33	19.67	1441		9504	10945
763.83	20.16	1460		13263	14723
764.33	20.66	1478		17735	19213
765.33	21.66	1513		28031	29544
766.33	22.66	1547		39818	41635

ECI-4 PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. ____ OF ____

DAM NAME: [illegible] /ID NO.: [illegible] JOB NO. ____

RESERVOIR ELEVATION-AREA DATA BY [illegible] DATE [illegible]

ELEV. (M.S.L.) (Ft.)	RESERVOIR SURFACE AREA (Acres)	REMARKS
745	0	Estimated streambed
753	67	Spillway Crest.
760	129	Measured on USGS Map
760.33	132	Top of Dam
770	232.5	Measured on USGS Map

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 1

DAM NAME: TEAL LAKE DAM (MO 10082) — JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS — BY D C — DATE 7/22/80

KLBK

1) DRAINAGE AREA, A = 6.43 sq. mi = (4114 acres)

2) LENGTH OF STREAM, L = (123 " × 2000' = 24600') = 4.66 mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 855'$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 753.0'$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 820'$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 757'$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10}) / 0.75L = .0034$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = \left(\frac{(11.9)(4.66^3)}{855-753}\right)^{.385} = 2.59$$

B) BY VELOCITY ESTIMATE,

SLOPE = .3 % ⟹ AVG. VELOCITY = 2

$t_c = L/V = 22600/60(60)2 = 3.14$

USE $t_c = 2.59$

9) LAG TIME, $t_\ell = 0.6\, t_c = 1.55$

10) UNIT DURATION, $D \leq t_\ell / 3 = .52$ $\nless$ 0.083 hr.

USE D = .25

11) TIME TO PEAK, $T_p = D/2 + t_\ell = 1.68$

12) PEAK DISCHARGE,

$q_p = (484 \times A) / T_p = 1856$ cfs

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  26 FEB 79
**********************************
   1           A1     DAM SAFETY INSPECTION MISSOURI
   2           A2     TEAL LAKE DAM (MO 10082)
   3           A3     PMF AND 50 PERCENT PMF
   4           B     300       0      15       0       0       0       0       0       0       0
   5           B1      5
   6           J       1       2       1
   7           J1      1      .5
   8           K        MO10082                                       1
   9           K1     INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMETERS
  10           M       1       2    6.43            6.43       1                       1
  11           P            24.8     100     120     130
  12           T                                                     -1     -93
  13           W2            1.55
  14           X                       1
  15           K       1 MO10082                                      1
  16           K1     ROUTE HYDROGRAPH THROUGH TEAL LAKE DAM (MO 10082)
  17           Y                                1       1
  18           Y1      1                                           -753      -1
  19           Y4    753   754.6  755.16  755.69  756.38  757.79  759.62  760.33  760.63  760.93
  20           Y4761.33  761.83  762.33  763.03  763.33  763.63  764.33  765.33  766.33
  21           Y5      0     125     225     340     475     750    1040    1327    1463    1761
  22           Y5   2407    3661    5465    9022   10945   14723   19213   29544   41635
  23           $A      0      67     129     132   232.5
  24           $E    745     753     760  760.33     770
  25           $S    753
  26           $D760.33
  27           K      99
```

```
******************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
 LAST MODIFICATION  26 FEB 79
******************************

RUN  DATE= 80/08/25.
     TIME= 13.02.22.

                    DAM SAFETY INSPECTION MISSOURI
                    TEAL LAKE DAM (MO 10082)
                    PMF AND 50 PERCENT PMF

                                   JOB SPECIFICATION
          NQ       NHR      NMIN     IDAY      IHR      IMIN     METRC     IPLT     IPRT     NSTAN
         300         0        15        3        0         0         0        0        0         0
                                     JOPER      NWT     LROPT     TRACE
                                         5        0         0         0

                              MULTI-PLAN ANALYSES TO BE PERFORMED
                                  NPLAN= 1 NRTIO= 2 LRTIO= 1
                 RTIOS=    1.00     .50

     **********         **********         **********         **********         **********

                                SUB-AREA RUNOFF COMPUTATION

                 INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMETERS

                           ISTAQ    ICOMP    IECON    ITAPE     JPLT     JPRT    INAME   ISTAGE    IAUTO
                          010082        0        0        0        0        0        1        0        0

                                        HYDROGRAPH DATA
              IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
                  1        2     6.43     0.00     6.43     1.00    0.000        0        1        0

                                         PRECIP DATA
                      SPFE      PMS       R6      R12      R24      R48      R72      R96
                      0.00    24.80   100.00   120.00   130.00     0.00     0.00     0.00

                                          LOSS DATA
          LROPT    STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
              0     0.00     0.00     1.00     0.00     0.00     1.00    -1.00   -93.00     0.00     0.00

               CURVE NO =  -93.00  WETNESS =    -1.00  EFFECT CN =    93.00

                                     UNIT HYDROGRAPH DATA
                                   TC=  0.00     LAG=  1.55

                                        RECESSION DATA
                            STRTQ=     0.00    QRCSN=     0.00    RTIOR= 1.00

              UNIT HYDROGRAPH 53 END OF PERIOD ORDINATES, TC=     0.00 HOURS, LAG=   1.55  VOL= 1.00
          119.      350.      716.     1212.     1614.     1829.     1845.     1730.     1529.     1274.
          960.      734.      574.      458.      362.      279.      221.      174.      135.      105.
```

83. 66. 51. 40. 32. 28. 20. 16. 13. 10.
7. 4. 1.

0

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.15	1	.04	0.00	.04	0.	1.02	13.45	151	0.00	0.00	0.00	0.
1.01	.30	2	.04	0.00	.04	0.	1.02	14.00	152	0.00	0.00	0.00	0.
1.01	.45	3	.04	0.00	.04	0.	1.02	14.15	153	0.00	0.00	0.00	0.
1.01	1.00	4	.04	.00	.04	0.	1.02	14.30	154	0.00	0.00	0.00	0.
1.01	1.15	5	.04	.00	.04	1.	1.02	14.45	155	0.00	0.00	0.00	0.
1.01	1.30	6	.04	.01	.03	2.	1.02	15.00	156	0.00	0.00	0.00	0.
1.01	1.45	7	.04	.01	.03	7.	1.02	15.15	157	0.00	0.00	0.00	0.
1.01	2.00	8	.04	.01	.03	15.	1.02	15.30	158	0.00	0.00	0.00	0.
1.01	2.15	9	.04	.02	.03	29.	1.02	15.45	159	0.00	0.00	0.00	0.
1.01	2.30	10	.04	.02	.02	49.	1.02	16.00	160	0.00	0.00	0.00	0.
1.01	2.45	11	.04	.02	.02	73.	1.02	16.15	161	0.00	0.00	0.00	0.
1.01	3.00	12	.04	.02	.02	101.	1.02	16.30	162	0.00	0.00	0.00	0.
1.01	3.15	13	.04	.02	.02	132.	1.02	16.45	163	0.00	0.00	0.00	0.
1.01	3.30	14	.04	.02	.02	165.	1.02	17.00	164	0.00	0.00	0.00	0.
1.01	3.45	15	.04	.03	.02	197.	1.02	17.15	165	0.00	0.00	0.00	0.
1.01	4.00	16	.04	.03	.02	229.	1.02	17.30	166	0.00	0.00	0.00	0.
1.01	4.15	17	.04	.03	.01	259.	1.02	17.45	167	0.00	0.00	0.00	0.
1.01	4.30	18	.04	.03	.01	288.	1.02	18.00	168	0.00	0.00	0.00	0.
1.01	4.45	19	.04	.03	.01	315.	1.02	18.15	169	0.00	0.00	0.00	0.
1.01	5.00	20	.04	.03	.01	340.	1.02	18.30	170	0.00	0.00	0.00	0.
1.01	5.15	21	.04	.03	.01	363.	1.02	18.45	171	0.00	0.00	0.00	0.
1.01	5.30	22	.04	.03	.01	384.	1.02	19.00	172	0.00	0.00	0.00	0.
1.01	5.45	23	.04	.03	.01	404.	1.02	19.15	173	0.00	0.00	0.00	0.
1.01	6.00	24	.04	.03	.01	422.	1.02	19.30	174	0.00	0.00	0.00	0.
1.01	6.15	25	.21	.17	.04	454.	1.02	19.45	175	0.00	0.00	0.00	0.
1.01	6.30	26	.21	.17	.03	517.	1.02	20.00	176	0.00	0.00	0.00	0.
1.01	6.45	27	.21	.18	.03	630.	1.02	20.15	177	0.00	0.00	0.00	0.
1.01	7.00	28	.21	.18	.02	813.	1.02	20.30	178	0.00	0.00	0.00	0.
1.01	7.15	29	.21	.19	.02	1056.	1.02	20.45	179	0.00	0.00	0.00	0.
1.01	7.30	30	.21	.19	.02	1335.	1.02	21.00	180	0.00	0.00	0.00	0.
1.01	7.45	31	.21	.19	.01	1624.	1.02	21.15	181	0.00	0.00	0.00	0.
1.01	8.00	32	.21	.19	.01	1902.	1.02	21.30	182	0.00	0.00	0.00	0.
1.01	8.15	33	.21	.20	.01	2156.	1.02	21.45	183	0.00	0.00	0.00	0.
1.01	8.30	34	.21	.20	.01	2377.	1.02	22.00	184	0.00	0.00	0.00	0.
1.01	8.45	35	.21	.20	.01	2554.	1.02	22.15	185	0.00	0.00	0.00	0.
1.01	9.00	36	.21	.20	.01	2698.	1.02	22.30	186	0.00	0.00	0.00	0.
1.01	9.15	37	.21	.20	.01	2816.	1.02	22.45	187	0.00	0.00	0.00	0.
1.01	9.30	38	.21	.20	.01	2914.	1.02	23.00	188	0.00	0.00	0.00	0.
1.01	9.45	39	.21	.20	.01	2995.	1.02	23.15	189	0.00	0.00	0.00	0.
1.01	10.00	40	.21	.20	.01	3062.	1.02	23.30	190	0.00	0.00	0.00	0.
1.01	10.15	41	.21	.20	.00	3117.	1.02	23.45	191	0.00	0.00	0.00	0.
1.01	10.30	42	.21	.20	.00	3162.	1.03	0.00	192	0.00	0.00	0.00	0.
1.01	10.45	43	.21	.20	.00	3200.	1.03	.15	193	0.00	0.00	0.00	0.
1.01	11.00	44	.21	.20	.00	3231.	1.03	.30	194	0.00	0.00	0.00	0.
1.01	11.15	45	.21	.20	.00	3257.	1.03	.45	195	0.00	0.00	0.00	0.
1.01	11.30	46	.21	.20	.00	3279.	1.03	1.00	196	0.00	0.00	0.00	0.
1.01	11.45	47	.21	.20	.00	3297.	1.03	1.15	197	1.00	0.00	0.00	0.
1.01	12.00	48	.21	.20	.00	3313.	1.03	1.30	198	0.00	0.00	0.00	0.
1.01	12.15	49	.62	.61	.01	3375.	1.03	1.45	199	0.00	0.00	0.00	0.
1.01	12.30	50	.62	.61	.01	3529.	1.03	2.00	200	0.00	0.00	0.00	0.
1.01	12.45	51	.62	.61	.01	3831.	1.03	2.15	201	0.00	0.00	0.00	0.
1.01	13.00	52	.62	.62	.00	4336.	1.03	2.30	202	0.00	0.00	0.00	0.
1.01	13.15	63	.74	.74	.00	5019.	1.03	2.45	203	0.00	0.00	0.00	0.
1.01	13.30	54	.74	.74	.00	5819.	1.03	3.00	204	0.00	0.00	0.00	0.

1.01	13.45	55	.76	.74	.00	6670.	1.03	3.15	205	0.00	0.00	0.00	0.
1.01	14.00	56	.74	.74	.00	7536.	1.03	3.30	206	0.00	0.00	0.00	0.
1.01	14.15	57	.93	.93	.00	8392.	1.03	3.45	207	0.00	0.00	0.00	0.
1.01	14.30	58	.93	.93	.00	9212.	1.03	4.00	208	0.00	0.00	0.00	0.
1.01	14.45	59	.93	.93	.00	9974.	1.03	4.15	209	0.00	0.00	0.00	0.
1.01	15.00	60	.93	.93	.00	10722.	1.03	4.30	210	0.00	0.00	0.00	0.
1.01	15.15	61	.94	.94	.00	11454.	1.03	4.45	211	0.00	0.00	0.00	0.
1.01	5.30	62	1.88	1.88	.00	12262.	1.03	5.00	212	0.00	0.00	0.00	0.
1.01	15.45	63	5.28	5.27	.01	13621.	1.03	5.15	213	0.00	0.00	0.00	0.
1.01	16.00	64	1.32	1.32	.08	15554.	1.03	5.30	214	0.00	0.00	0.00	0.
1.01	16.15	65	.87	.87	.00	18157.	1.03	5.45	215	0.00	0.00	0.00	0.
1.01	16.30	66	.87	.87	.00	21189.	1.03	6.00	216	0.00	0.00	0.00	0.
1.01	16.45	67	.87	.87	.00	23570.	1.03	6.15	217	0.00	0.00	0.00	0.
1.01	17.00	68	.87	.87	.00	24819.	1.03	6.30	218	0.00	0.00	0.00	0.
1.01	17.15	69	.68	.64	.00	24906.	1.03	6.45	219	0.00	0.00	0.00	0.
1.01	17.30	70	.68	.68	.00	24181.	1.03	7.00	220	0.00	0.00	0.00	0.
1.01	17.45	71	.68	.68	.00	22880.	1.03	7.15	221	0.00	0.00	0.00	0.
1.01	18.00	72	.64	.68	.30	21142.	1.03	7.30	222	0.00	0.00	0.00	0.
1.01	18.15	73	.06	.06	.00	19062.	1.03	7.45	223	0.00	0.00	0.00	0.
1.01	18.30	74	.06	.06	.00	17222.	1.03	8.00	224	0.00	0.00	0.00	0.
1.01	18.45	75	.06	.06	.00	15523.	1.03	8.15	225	0.00	0.00	0.00	0.
1.01	19.00	76	.06	.06	.00	13779.	1.03	8.30	226	0.00	0.00	0.00	0.
1.01	19.15	77	.06	.06	.00	11942.	1.03	8.45	227	0.00	0.00	0.00	0.
1.01	19.30	78	.06	.06	.00	10111.	1.03	9.00	228	0.00	0.00	0.00	0.
1.01	19.45	79	.06	.06	.00	8455.	1.03	9.15	229	0.00	0.00	0.00	0.
1.01	20.00	80	.06	.06	.00	6976.	1.03	9.30	230	0.00	0.00	0.00	0.
1.01	20.15	81	.06	.06	.00	5700.	1.03	9.45	231	0.00	0.00	0.00	0.
1.01	20.30	82	.06	.06	.00	4653.	1.03	10.00	232	0.00	0.00	0.00	0.
1.01	20.45	83	.06	.06	.00	3864.	1.03	10.15	233	0.00	0.00	0.00	0.
1.01	21.00	84	.06	.06	.00	3256.	1.03	10.30	234	0.00	0.00	0.00	0.
1.01	21.15	85	.06	.06	.00	2777.	1.03	10.45	235	0.00	0.00	0.00	0.
1.01	21.30	86	.06	.06	.00	2396.	1.03	11.00	236	0.00	0.00	0.00	0.
1.01	21.45	87	.06	.06	.00	2097.	1.03	11.15	237	0.00	0.00	0.00	0.
1.01	22.00	88	.06	.06	.00	1865.	1.03	11.30	238	0.00	0.00	0.00	0.
1.01	22.15	89	.06	.06	.00	1683.	1.03	11.45	239	0.00	0.00	0.00	0.
1.01	22.30	90	.06	.06	.00	1542.	1.03	12.00	240	0.00	0.00	0.00	0.
1.01	22.45	91	.06	.06	.00	1428.	1.03	12.15	241	0.00	0.00	0.00	0.
1.01	23.00	92	.06	.06	.00	1336.	1.03	12.30	242	0.00	0.00	0.00	0.
1.01	23.15	93	.06	.06	.00	1262.	1.03	12.45	243	0.00	0.00	0.00	0.
1.01	23.30	94	.06	.06	.00	1200.	1.03	13.00	244	0.00	0.00	0.00	0.
1.01	23.45	95	.06	.06	.00	1150.	1.03	13.15	245	0.00	0.00	0.00	0.
1.02	0.00	96	.06	.06	.00	1114.	1.03	13.30	246	0.00	0.00	0.00	0.
1.02	.15	97	0.00	0.00	0.00	1084.	1.03	13.45	247	0.00	0.00	0.00	0.
1.02	.30	98	0.00	0.00	0.00	1045.	1.03	14.00	248	0.00	0.00	0.00	0.
1.02	.45	99	0.00	0.00	0.00	988.	1.03	14.15	249	0.00	0.00	0.00	0.
1.02	1.00	100	0.00	0.00	0.00	902.	1.03	14.30	250	0.00	0.00	0.00	0.
1.02	1.15	101	0.00	0.00	0.00	793.	1.03	14.45	251	0.00	0.00	0.00	0.
1.02	1.30	102	0.00	0.00	0.00	674.	1.03	15.00	252	0.00	0.00	0.00	0.
1.02	1.45	103	0.00	0.00	0.00	555.	1.03	15.15	253	0.00	0.00	0.00	0.
1.02	2.00	104	0.00	0.00	0.00	445.	1.03	15.30	254	0.00	0.00	0.00	0.
1.02	2.15	105	0.00	0.00	0.00	350.	1.03	15.45	255	0.00	0.00	0.00	0.
1.02	2.30	106	0.00	0.00	0.00	271.	1.03	16.00	256	0.00	0.00	0.00	0.
1.02	2.45	107	0.00	0.00	0.00	211.	1.03	16.15	257	0.00	0.00	0.00	0.
1.02	3.00	108	0.00	0.00	0.00	166.	1.03	16.30	258	0.00	0.00	0.00	0.
1.02	3.15	109	0.00	0.00	0.00	130.	1.03	16.45	259	0.00	0.00	0.00	0.
1.02	3.30	110	0.00	0.00	0.00	102.	1.03	17.00	260	0.00	0.00	0.00	0.
1.02	3.45	111	0.00	0.00	0.00	80.	1.03	17.15	261	0.00	0.00	0.00	0.
1.02	4.00	112	0.00	0.00	0.00	62.	1.03	17.30	262	0.00	0.00	0.00	0.
1.02	4.15	113	0.00	0.00	0.00	49.	1.03	17.45	263	0.00	0.00	0.00	0.
1.02	4.30	114	0.00	0.00	0.00	30.	1.03	18.00	264	0.00	0.00	0.00	0.

1.02	4.45	115	0.00	0.00	0.00	29.	1.03	18.15	265	0.00	0.00	0.00	0.
1.02	5.00	116	0.00	0.00	0.00	23.	1.03	18.30	266	0.00	0.00	0.00	0.
1.02	5.15	117	0.00	0.00	0.00	18.	1.03	18.45	267	0.00	0.00	0.00	0.
1.02	5.30	118	0.00	0.00	0.00	14.	1.03	19.00	268	0.00	0.00	0.00	0.
1.02	5.45	119	0.00	0.00	0.00	10.	1.03	19.15	269	0.00	0.00	0.00	0.
1.02	6.00	120	0.00	0.00	0.00	8.	1.03	19.30	270	0.00	0.00	0.00	0.
1.02	6.15	121	0.00	0.00	0.00	6.	1.03	19.45	271	0.00	0.00	0.00	0.
1.02	6.30	122	0.00	0.00	0.00	4.	1.03	20.00	272	0.00	0.00	0.00	0.
1.02	6.45	123	0.00	0.00	0.00	3.	1.03	20.15	273	0.00	0.00	0.00	0.
1.02	7.00	124	0.00	0.00	0.00	2.	1.03	20.30	274	0.00	0.00	0.00	0.
1.02	7.15	125	0.00	0.00	0.00	1.	1.03	20.45	275	0.00	0.00	0.00	0.
1.02	7.30	126	0.00	0.00	0.00	1.	1.03	21.00	276	0.00	0.00	0.00	0.
1.02	7.45	127	0.00	0.00	0.00	0.	1.03	21.15	277	0.00	0.00	0.00	0.
1.02	8.00	128	0.00	0.00	0.00	0.	1.03	21.30	278	0.00	0.00	0.00	0.
1.02	8.15	129	0.00	0.00	0.00	0.	1.03	21.45	279	0.00	0.00	0.00	0.
1.02	8.30	130	0.00	0.00	0.00	0.	1.03	22.00	280	0.00	0.00	0.00	0.
1.02	8.45	131	0.00	0.00	0.00	0.	1.03	22.15	281	0.00	0.00	0.00	0.
1.02	9.00	132	0.00	0.00	0.00	0.	1.03	22.30	282	0.00	0.00	0.00	0.
1.02	9.15	133	0.00	0.00	0.00	0.	1.03	22.45	283	0.00	0.00	0.00	0.
1.02	9.30	134	0.00	0.00	0.00	0.	1.03	23.00	284	0.00	0.00	0.00	0.
1.02	9.45	135	0.00	0.00	0.00	0.	1.03	23.15	285	0.00	0.00	0.00	0.
1.02	10.00	136	0.00	0.00	0.00	0.	1.03	23.30	286	0.00	0.00	0.00	0.
1.02	10.15	137	0.00	0.00	0.00	0.	1.03	23.45	287	0.00	0.00	0.00	0.
1.02	10.30	138	0.00	0.00	0.00	0.	1.04	0.00	288	0.00	0.00	0.00	0.
1.02	10.45	139	0.00	0.00	0.00	0.	1.04	.15	289	0.00	0.00	0.00	0.
1.02	11.00	140	0.00	0.00	0.00	0.	1.04	.30	290	0.00	0.00	0.00	0.
1.02	11.15	141	0.00	0.00	0.00	0.	1.04	.45	291	0.00	0.00	0.00	0.
1.02	11.30	142	0.00	0.00	0.00	0.	1.04	1.00	292	0.00	0.00	0.00	0.
1.02	11.45	143	0.00	0.00	0.00	0.	1.04	1.15	293	0.00	0.00	0.00	0.
1.02	12.00	144	0.00	0.00	0.00	0.	1.04	1.30	294	0.00	0.00	0.00	0.
1.02	12.15	145	0.00	0.00	0.00	0.	1.04	1.45	295	0.00	0.00	0.00	0.
1.02	12.30	146	0.00	0.00	0.00	0.	1.04	2.00	296	0.00	0.00	0.00	0.
1.02	12.45	147	0.00	0.00	0.00	0.	1.04	2.15	297	0.00	0.00	0.00	0.
1.02	13.00	148	0.00	0.00	0.00	0.	1.04	2.30	298	0.00	0.00	0.00	0.
1.02	13.15	149	0.00	0.00	0.00	0.	1.04	2.45	299	0.00	0.00	0.00	0.
1.02	13.30	150	0.00	0.00	0.00	0.	1.04	3.00	300	0.00	0.00	0.00	0.

SUM 32.24 31.35 .89 520143.
(819.)(796.)(23.)(14728.81)

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	24908.	15641.	5409.	1806.	520144.
CMS	705.	443.	153.	51.	14729.
INCHES		22.63	31.30	31.35	31.35
MM		574.76	795.08	796.39	796.39
AC-FT		7756.	10729.	10747.	10747.
THOUS CU M		9567.	13234.	13256.	13256.

HYDROGRAPH AT STA01COB2 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	1.	2.	7.	15.	29.	49.
73.	101.	132.	165.	197.	229.	259.	288.	315.	340.
363.	384.	404.	422.	454.	517.	630.	813.	1056.	1335.
1624.	1902.	2156.	2377.	2854.	2698.	2816.	2914.	2995.	3062.
3117.	3162.	3200.	3231.	3257.	3279.	3297.	3313.	3375.	3529.
3851.	4336.	5019.	5819.	6670.	7536.	8392.	9212.	9974.	10722.
11454.	12262.	13621.	15554.	18157.	21189.	23570.	24819.	24908.	24181.
22880.	21142.	19062.	17222.	15523.	13779.	11942.	10111.	8455.	6976.
5700.	4653.	3804.	3256.	2777.	2396.	2097.	1865.	1683.	1542.

1428.	1336.	1262.	1200.	1150.	1114.	1084.	1045.	988.	902.
793.	674.	595.	445.	360.	271.	211.	166.	130.	102.
80.	62.	49.	38.	29.	23.	18.	14.	10.	8.
6.	4.	3.	2.	1.	1.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	24908.	15641.	5409.	1806.	520144.
CMS	705.	443.	153.	51.	14729.
INCHES		22.63	31.30	31.35	31.35
MM		574.76	795.08	796.39	796.39
AC-FT		7756.	10729.	10747.	10747.
THOUS CU M		9567.	13234.	13256.	13256.

HYDROGRAPH AT STA010082 FOR PLAN 1, RTIO 2

0.	0.	0.	0.	3.	1.	3.	8.	15.	24.
36.	51.	66.	82.	99.	115.	130.	144.	157.	170.
191.	192.	202.	211.	227.	259.	315.	407.	528.	669.
812.	961.	1078.	1188.	1277.	1349.	1406.	1457.	1498.	1531.
1558.	1581.	1600.	1616.	1629.	1640.	1649.	1656.	1687.	1764.
1916.	2168.	2510.	2909.	3335.	3768.	4196.	4606.	4987.	5361.
5727.	6131.	6810.	7777.	9079.	10594.	11785.	12410.	12454.	12090.
11440.	10571.	9531.	8611.	7761.	6889.	5971.	5055.	4227.	3488.
2850.	2326.	1932.	1628.	1388.	1198.	1048.	933.	841.	771.
714.	668.	631.	600.	575.	557.	542.	523.	494.	451.
397.	337.	278.	223.	175.	135.	106.	83.	65.	51.
40.	31.	24.	19.	15.	11.	9.	7.	5.	4.
3.	2.	2.	1.	1.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

```
     0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
     0.        0.        0.        0.        0.        0.        0.        0.        0.        0.
     0.        0.        0.        0.        0.        0.        0.        0.        0.        0.

                          PEAK    6-HOUR   24-HOUR   72-HOUR   TOTAL VOLUME
                 CFS     12454.    7821.     2705.      903.      260072.
                 CMS       353.     221.       77.       26.        7364.
              INCHES               11.31     15.69     15.68        15.68
                  MM              287.38    397.59    398.20       398.20
               AC-FT               3878.     5365.     5373.        5373.
          THOUS CU M               4783.     6617.     6628.        6628.


**********          **********          **********          **********          **********

                                   HYDROGRAPH ROUTING

                 ROUTE HYDROGRAPH THROUGH TEAL LAKE DAM (MO 10082)

                   ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                  010082       1       0       0       0       0       1       0       0
                                         ROUTING DATA
           QLOSS   CLOSS     AVG   IRES   ISAME    IOPT    IPMP            LSTR
             0.0   0.000    0.00      1       1       0       0               0

                   NSTPS   NSTDL     LAG   AMSKK       X     TSK   STORA  ISPRAT
                       1       0       0   0.000   0.000   0.000   -753.      -1

   STAGE     753.00    754.60    755.16    755.69    756.38    757.79    759.62    760.33    760.63    760.93
             761.33    761.83    762.33    763.03    763.33    763.83    764.33    765.33    766.33

   FLOW        0.00    125.00    225.00    340.00    475.00    750.00   1040.00   1327.00   1463.00   1761.00
            2407.00   3661.00   5465.00   9022.00  10995.00  14723.00  19213.00  29544.00  41635.00

SURFACE AREA=        0.       67.      129.      13?.      233.

   CAPACITY=         0.      179.      653.      896.     2636.

  ELEVATION=       745.      753.      760.      760.      770.

                 CREL   SPWID   COQW   EXPW   ELEVL   COQL   CAREA   EXPL
                753.0     0.0    0.0    0.0     0.0    0.0     0.0    0.0

                                     DAM DATA
                            TOPEL   COQD   EXPD  DAMWID
                            760.3    0.0    0.0     0.

                       STATION 010082, PLAN 1, RATIO 1

                     END-OF-PERIOD HYDROGRAPH ORDINATES

                                     OUTFLOW
          0.        0.        0.        0.        0.        0.        0.        0.        1.        2.
          3.        5.        8.       11.       15.       20.       25.       31.       37.       43.
         50.       57.       65.       72.       80.       89.       99.      112.      132.      180.
        239.      316.      394.      474.      556.      638.      718.      788.      851.      912.
        971.     1029.     1149.     1278.     1407.     1609.     1888.     2192.     2450.     2760.
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

OPERATION	STATION	AREA	PLAN	RATIO 1 1.00	RATIO 2 .50
HYDROGRAPH AT	010082	6.43 (16.65)	1	24908. (705.32)(	12454. 352.66)(
ROUTED TO	010082	6.43 (16.65)	1	24544. (695.00)(	12190. 345.17)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	753.00	753.00	760.33
STORAGE	179.	179.	896.
OUTFLOW	0.	0.	1327.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	764.85	4.52	1888.	24544.	14.25	17.50	0.00
.50	763.49	3.16	1360.	12190.	9.25	17.50	0.00

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*************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
*************************************

RUN  DATE* 80/08/25.
     TIME* 13.05.18.

                 DAM SAFETY INSPECTION MISSOURI
                 TEAL LAKE DAM (MO 10082)
                 PERCENT PMF

                                   JOB SPECIFICATION
           NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
          300        0       15        0        0        0        0        0       -4        0
                                   JOPER      NWT    LROPT    TRACE
                                       5        0        0        0

                          MULTI-PLAN ANALYSES TO BE PERFORMED
                              NPLAN= 1 NRTIO= 5 LRTIO= 1
          RTIOS=    .10     .11     .12     .13     .14

  **********      **********      **********      **********      **********

                              SUB-AREA RUNOFF COMPUTATION

             INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMETERS

                 ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                010082       0       0       0       0       0       1       0       0

                                   HYDROGRAPH DATA
        IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
            1      2    6.43    0.00    6.43    1.00   0.000       0       1       0

                                    PRECIP DATA
              SPFE     PMS      R6     R12     R24     R48     R72     R96
              0.00   24.80  100.00  120.00  130.00    0.00    0.00    0.00

                                     LOSS DATA
     LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
              0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -93.00    0.00    0.00

           CURVE NO =  -93.00  WETNESS =   -1.00  EFFECT CN =   93.00

                               UNIT HYDROGRAPH DATA
                            TC=  0.00     LAG=  1.58

                                  RECESSION DATA
                   STRTQ=    0.00    QRCSN=    0.00    RTIOR=  1.00

                               END-OF-PERIOD FLOW
  MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q      MO.DA  HR.MN  PERIOD   RAIN   EXCS   LOSS    COMP Q
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                                                        SUM   32.24   31.35    .89   520145.
                                                            ( 819.)( 796.)(  23.)(14728.81)

          **********          **********          **********          **********          **********

                                        HYDROGRAPH ROUTING

                      ROUTE HYDROGRAPH THROUGH TEAL LAKE DAM (MO 10082)

                            ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE  IAUTO
                           010082       1       0       0      0       0       1       0      0
                                                  ROUTING DATA
                    QLOSS   CLOSS     AVG    IRES   ISAME   IOPT    IPMP            LSTR
                      0.0   0.000    0.00       1       1      0       0               0

                            NSTPS   NSTDL     LAG   AMSKK      X     TSK   STORA  ISPRAT
                                1       0       0   0.000  0.000   0.000   -753.     -1

      STAGE     753.00     754.60     755.16     755.69     756.36     757.79     759.62     760.33     760.63     760.93
                761.33     761.83     762.33     763.03     763.33     763.83     764.33     765.33     766.33

       FLOW       0.00     125.00     225.00     340.00     475.00     750.00    1040.00    1327.00    1463.00    1761.00
               2407.00    3601.00    5465.00    9022.00   10945.00   14723.00   19213.00   29544.00   41635.00

SURFACE AREA=       0.        67.       129.       132.       233.

    CAPACITY=       0.       179.       853.       896.      2636.

   ELEVATION=     745.       753.       760.       760.       770.

                    CREL    SPWID    COQW    EXPW   ELEVL    COQL   CAREA    EXPL
                   753.0      0.0     0.0     0.0     0.0     0.0     0.0     0.0

                                                 DAM DATA
                                        TOPEL    COQD    EXPD   DAMWID
                                        760.3     0.0     0.0       0.

    PEAK OUTFLOW IS      1005. AT TIME  19.50 HOURS

    PEAK OUTFLOW IS      1140. AT TIME  19.50 HOURS

    PEAK OUTFLOW IS      1303. AT TIME  19.50 HOURS

    PEAK OUTFLOW IS      1478. AT TIME  19.25 HOURS

    PEAK OUTFLOW IS      1775. AT TIME  19.25 HOURS

          **********          **********          **********          **********          **********
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PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

				RATIOS APPLIED TO FLOWS				
OPERATION	STATION	AREA	PLAN	RATIO 1 .10	RATIO 2 .11	RATIO 3 .12	RATIO 4 .13	RATIO 5 .14
HYDROGRAPH AT	010082	6.43	1	2491.	2740.	2989.	3238.	3487.
	(	16.65)	(	70.53)(	77.59)(	84.64)(	91.69)(	98.74)(
ROUTED TO	010082	6.43	1	1005.	1140.	1303.	1478.	1775.
	(	16.65)	(	28.45)(	32.28)(	36.88)(	41.86)(	50.27)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	753.00	753.00	760.33
STORAGE	179.	179.	896.
OUTFLOW	0.	0.	1327.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	759.40	0.00	777.	1005.	0.00	19.50	0.00
.11	759.87	0.00	836.	1140.	0.00	19.50	0.00
.12	760.27	0.00	888.	1303.	0.00	19.50	0.00
.13	760.65	.32	938.	1478.	2.25	19.25	0.00
.14	760.94	.61	978.	1775.	3.00	19.25	0.00

ATE
LME